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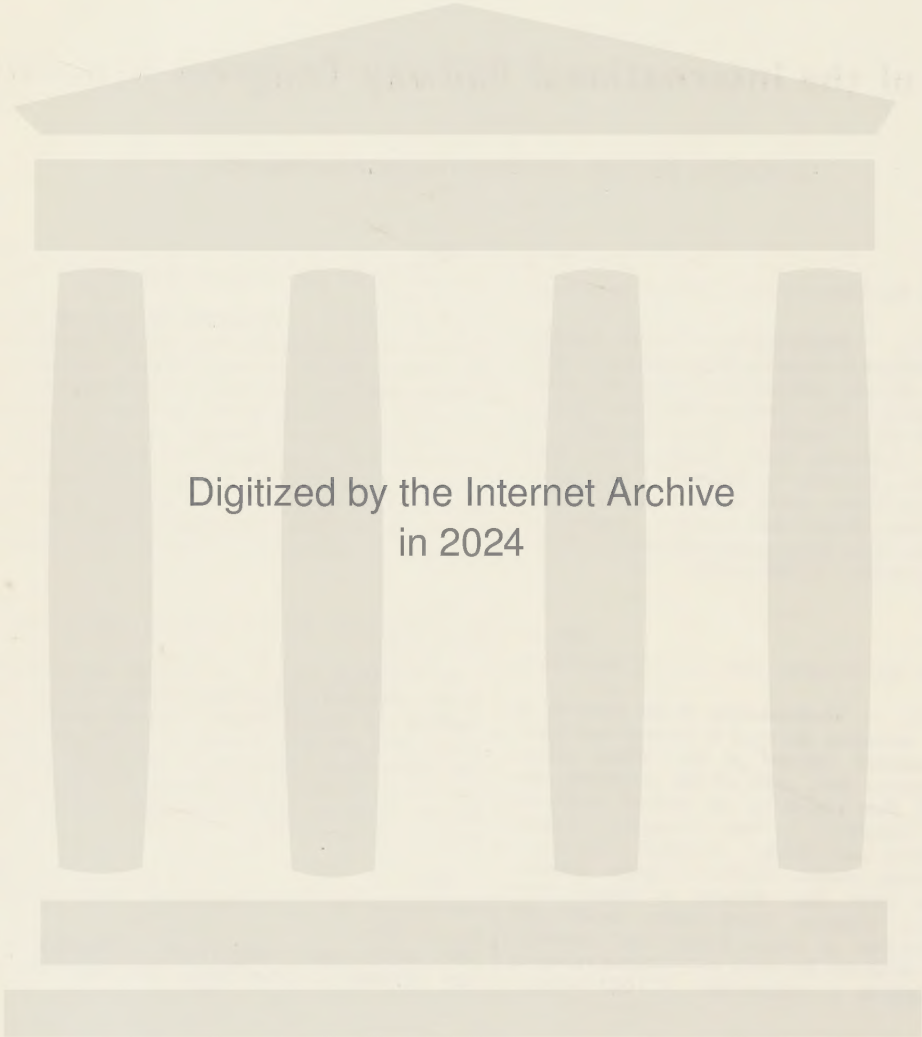

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MONTHLY BULLETIN

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

(ENGLISH EDITION)

PUBLISHING and EDITORIAL OFFICES : 19, RUE DU BEAU-SITE, BRUSSELS

Yearly subscription for 1953 : { Belgium . . . . . 700 Belgian Francs / Universal Postal Union. . . 800 Belgian Francs }

Price of this single copy : 125 Belgian Francs (not including postage).

Subscriptions and orders for single copies (January 1931 and later editions) to be addressed to the General Secretary, International Railway Congress Association, 19, rue du Beau-Site, Brussels (Belgium).

Orders for copies previous to January 1931 should be addressed to Messrs. Weissenbruch & Co. Ltd., Printers, 49, rue du Poinçon, Brussels.

Advertisements : All communications should be addressed to the Association, **19, rue du Beau-Site, Brussels.**

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An edition in French is also published.

Vol. XXX. — No. 11. November 1953.

BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[725 .3]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

16th SESSION (LONDON, 1954).

QUESTION 2.

A) Modernisation of station buildings and methods employed in financing modernisation projects.

B) Standardisation of unit construction applied to railway building.

REPORT

(America (North and South), Australia (Commonwealth of), Burma, Ceylon, Denmark, Egypt, Finland, India, Indonesia, Irak, Iran, Republic of Ireland, New Zealand, Norway, Pakistan, South Africa, Sweden and the United Kingdom of Great Britain and Northern Ireland and the territories for whose international relations the United Kingdom is responsible),

by Dr. F. F. C. Curtis,

Architect, British Transport Commission, British Railways.

Question « A » is devoted to an examination of the financial bases of the modernisation of railway buildings (stations) : Question « B » to the development and employment of standardised systems of unit construction.

In considering the answers to these two sets of questions, it has to be remembered that, out of the 23 Administrations submitting replies, some are privately, others publicly owned and operated : among them are represented several degrees of size and development, and several different economic and financial structures. At the same time a broad similarity in the answers to particular questions argues that railway architectural and engineering problems are similar the world over and it would seem that younger systems have based their work on the experience of older ones, particularly

where managerial or executive staff have had training and experience on other railways.

QUESTION « A ».

SUB-QUESTION REFERRED TO SHOWN IN BRACKETS.

(1). — When station reconstruction (including modernisation in whole or in part) is envisaged it is not the general rule for proposals to be accompanied by statistics of anticipated traffic and net revenue. For one thing, it may not always be possible to estimate this (it may be that the psychological effect of reconstruction alone will become a valuable invisible asset), and for another, different considerations may carry more weight. In developing systems such as those of Africa, India and Indonesia new buildings will be provided because they are required where none already exist, or because temporary structures must be replaced. Again, it is probable that some uneconomic projects must be carried out in the same way that some uneconomic services must be maintained, or modernisation may be necessary merely to maintain revenue at the existing level (Norway).

The chief exception is British Railways, which does assess traffic and revenue expected as far as possible. They and the Chicago, Burlington and Quincy Railroad Company of America submit details of the station earnings over a past period of years, while an interesting answer, supplied by the London Midland Region of British Railways, mentions the practice of back-checking selected schemes to establish how far expectations have been realised : similar investigations are no doubt made by other organisations.

Generally an estimate of costs at least is provided, which may be linked with an attempt to forecast future traffic development (Swedish State Railways) : but in every case the general policy of the organisation, or the particular policy as affected by the circumstances of the time, will have its effect.

(2). — Capital expenditure on modernisation is not always related to traffic originating and terminating at the particular station. Apart from the question of exchange and transit traffic, other factors considered are the age and condition of the buildings, the existing maintenance liabilities, and the possible economies in structure or staff where either the traffic pattern has altered or improved methods of working are available.

(4). — Where the anticipated net revenue from reconstruction is assessed the annual maintenance and renewal liabilities may be calculated on a uniform or a differential basis, depending upon the organisation's building programme and its financial structure; no clear trend emerges here.

(6). — Very large reconstruction projects are usually carried out in stages, each financed separately, and the long-term capital expenditure may be provided for in several ways, largely depending upon whether a railway system is publicly or privately operated. Since State-owned systems are generally obliged to work to a budget voted them by Parliament, long-term planning of major reconstructions will be a necessity. Loan capital is employed by a few systems (East Africa, Ceylon), but it would probably be true to say that expenditure would be met, wherever possible, from revenue, working capital, or renewal and depreciation reserves.

(3). — No capital contribution, however, is sought from ancillary services on stations such as shops, restaurants, hotels and advertising display, as is the case on some continental systems, unless work is directly carried out for them. Such tenants pay rent or a percentage of their profits. It may be difficult to adjust these unless existing agreements can be cancelled.

This attitude seems unadventurous : presumably tenants take up these concessions because they are profitable. Were it not for the station they would not exist, and it might be assumed that well-designed new

buildings are at least as likely to attract more traffic and more trade as not.

Again, local authorities make no contribution to reconstruction except where work is directly carried out for their benefit (this usually involves only road or bridge works, the cost of which is shared proportionately with the railway), although rent may be paid for special accommodation. The habit of regarding a railway station as a civic building as much as the town hall or public library (e.g. Switzerland), is not common, though in many cases it is the first town building a visitor sees and uses, and one would expect that local pride allied with commercial instinct would see here a great opportunity.

(7). — In minor works, replacements, maintenance and repair are generally charged to revenue, improvements to capital account : but there are exceptions — in America the accounting procedures and regulations of the Interstate Commerce Commission are taken as a guide, while in India a net return of 4.25 % is required on new work debited to capital, and unremunerative work involving mostly passenger amenities is charged to a development fund created out of revenue.

(5). — In the planning stage of all reconstruction schemes it is the general practice to try to make economies by taking advantage of the most up-to-date equipment and methods of working : lavatory, waiting room and office facilities may be grouped or amalgamated, and staff reduced with resulting economies in the size of the building (and, therefore, in materials, service and maintenance costs). However, although the point has not been raised, it is conceivable that the reverse may apply : that increased efficiency may allow the handling of more traffic which will require larger buildings. Be that as it may, this process is, of course, a continuous one, and is achieved by constant consultation between all parties concerned : thus in the planning stage several successive preliminary schemes may have to be examined and rejected.

QUESTION « B ».

SUB-QUESTION REFERRED TO SHOWN IN BRACKETS.

(1) and (3). — The development of standardised unit construction depends on the character of the railway system. For railway purposes it appears to be not so much the answer to a long-term programme of buildings which can be accurately forecast but to a need for temporary structures which can be quickly built and easily enlarged or adapted.

Almost every country makes use of standard units or standard construction in some way while complete constructional systems are mainly based on combinations of post and panel walls with beam and slab roofs. The types of structure for which these are used vary from platforms, fencing, kiosks and lengthmen's huts to houses, service buildings, engine and goods sheds.

With certain exceptions modular or grid planning is not used, except insofar as the particular building components used dictate a dimensional pattern. No special attention appears to have been given to insulation problems, since the structures involved probably need no particular level of insulation, but at the same time a unit system usually includes a double skin or « sandwich » cladding, and the question has obviously been considered in developing these structures, since satisfactory results are reported. In erection, railway labour is generally used for small projects only, and because these jobs — a small proportion of the building programme — are themselves comparatively small, there is no problem of storage or transport of components : in many cases units are made as required.

Perhaps the most significant answers are those which show countries using standard components developed in collaboration with the building trade and building research institutes (Norway, Sweden, Den-

mark). The logical answer to the railway problem lies perhaps in the development of standard equipment and furniture rather than of standard buildings, a trend which runs parallel to current thoughts on prefabrication in general. This allows for economy, speed and flexibility, without the disadvantages of possible shortage of materials or radical changes in technique.

To deal in more detail with complete systems of unit construction, several different modules are mentioned : 4″, 60 cm., 36″, 39″, 40″, together with bays of 8′ 6″, 10′ 0″ and 12′ 0″. Four inches is a favourite American module applicable to brick and timber standard construction, and 40″ a favourite English one, recommended by the British Standards Institution as conforming to the metre and having decimal properties, while giving door, corridor and staircase widths (1 unit), door heights (2 units) and 10′ 0″ bays (3 units). But it does not appear common practice to use these modules in more than one dimension : usually they make up the length of a building rather than the width.

Most work in this field appears to have been done by British Railways both before and after nationalisation : but this has not all been co-ordinated nor carried to a conclusion. The L.N.E.R. established standards for :

Station signs.
Notice & Poster Boards.
Barriers and gates.
Sanitary fittings.
Heating, lighting, ventilation.
Booking offices.

The L.M.S. studied principles of station planning and related accommodation to volume of traffic including :—

Number and sizes of entrance doors.
Sizes of concourse.
Number of ticket windows and barriers.
Number of lavatories.
Widths of subways and staircases.

The G.W.R. studied :

Capacity of approach roads.
Time and space requirements for alighting passengers.
Booking Office statistics.
Time and space requirements for platforms and concourses.
Speed and volume of pedestrian traffic in circulation.

In standard unit construction the G.W.R. experimented with seats, window surrounds, built-in furniture, roof panels and aluminium panels for country and suburban platform buildings.

The L.M.S. developed a system based on a module of 40″ using steel columns with pre-cast concrete or enamelled steel panels giving a minimum wall thickness of 2 1/2″ and a U. value of 0.25. Two prototypes were built but full-scale production was never started.

Currently the Eastern Region of British Railways have developed a system, again based on a 40″ module, using pre-cast concrete columns and eaves, beams with standard metal windows and several types of cavity or sandwich panel infillings : roofs are of foamed slag slabs laid between pre-cast beams with an in-situ topping. This system is intended for a large programme of welfare buildings and allows flexible planning.

(4). — As previously indicated unit construction has nowhere been very closely bound to any particular type of railway building (excepting the L.M.S. and Eastern Regions of British Railways), rather it has been considered as a flexible and economic auxiliary to normal building methods. Therefore, it is not strictly related to the development of standard practice in station working, except insofar as standard equipment or components are involved. The two are likely to proceed at different rates of development and any too close a link might prove to be uneconomical. A general tendency is to standardise equipment for

stations of similar size, but obviously a station too carefully « tailor made » might soon prove uneconomic.

(5). — In this connection uniformity of appearance and colour treatment is not generally sought, although standard colours are used by several systems (British Railways, Denmark, various American Companies) : local conditions and environment are usually the first consideration.

(11). — In small scale improvements at existing stations much will depend on the units available. Obviously part or whole of a building reconstructed in a post and panel system may not blend with older buildings or their surroundings unless facings of a suitable character are available, although a complete suburban reconstruction may be permissible. On the other hand, standard components, furniture and fittings may easily be introduced : booking office windows, poster panels, seats, lights and fencing would be examples of these.

(2). — It is the general opinion, however, that unit construction when used in appropriate cases is both cheaper in first costs and quicker to build. In material and maintenance costs it is not necessarily cheaper, although on the latter point experience is lacking. Materials used are generally normal building materials, even if prefabricated in unusual ways. With complicated systems comparatively large building programmes and a constant supply of materials might be needed to keep costs down, but the ability to salvage and re-use components also makes for economy.

(10). — The shortage of raw materials — chiefly the world-wide shortage of steel and cement — has in some cases affected the application of unit construction. In certain cases unit systems have been expressly designed to exclude key materials, in others it has been possible to use substitutes. But shortages are just as likely to affect normal building operations, and any material might become scarce at some time because of national or international circumstances.

(9). — The same arguments hold good when considering the effect of fluctuating costs of materials and labour. It is generally agreed that these have no adverse effects on the application of unit construction. Fluctuations in the cost of building labour may encourage the use of such systems, while fluctuations in the cost of materials or factory labour will affect other forms of building no less. Traditional and unit construction may be held to be complementary to each other, and any particular circumstances affecting the employment of either will be weighed at the planning stage of each project.

(7). — Technical developments in the building industry might be thought to affect unit construction, but it appears that adjustments can be made if required. The pace of building development is relatively slow because of the need for testing and assimilating new products, and it is unlikely to outstrip the progress of prefabricated systems which, consisting of simple elements such as column, beam, and slab, should be easily adjustable to new materials.

(8). — Since standardisation of unit construction has a limited scope, being generally applicable only to small one-storey buildings which do not in any case present great structural problems, it does not, with few exceptions, destroy initiative in developing new forms of construction. Anything but the simplest one or two-cell building must still be planned and the elements of the system adapted to it. But standards must be constantly reviewed so that advantage is taken of new developments; the drawing office time saved by the application of standards can be used for this purpose.

(6). — As an additional development of unit construction, several railways have made use of small huts and kiosks, pre-

assembled and transported to prepared sites (also small houses — Finland). Factors affecting these are the loading gauge, the size of crane needed to lift the building and the availability of the track for the necessary time. Unless either a very large number of them are required at one time or many temporary buildings are needed which can be moved to other sites at short notice, it would not seem that there is much scope for development in this field, especially in fully-developed railway systems where new works in remote places are not required.

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

16th SESSION (LONDON, 1954).

QUESTION 7.

Modernisation of the methods to be adopted for recruiting the staff in number and qualification.

Harmonious renewal of the various ranks, indispensable reserve lists, ratio of the permanent and temporary staff.

Part played by the medical service in the recruiting.

REPORT

America (North and South), Australia (Commonwealth of), Burma, Ceylon, Denmark, Egypt, Finland, India, Indonesia, Irak, Iran, Republic of Ireland, New Zealand, Norway, Pakistan, South Africa, Sweden and the United Kingdom of Great Britain and Northern Ireland and the territories for whose international relations the United Kingdom is responsible,

by Frank LEMASS,

General Manager, Coras Iompair Eireann, DUBLIN (Ireland).

INTRODUCTION.

The Questionnaire on which this report is based was sent to thirty seven Administrations, and replies were received from the undermentioned nineteen :—

British Railways;
London Transport Executive;
East African Railways & Harbours;
South African Railways & Harbours;
Ceylon Government Railway;
Victorian Government Railways;
New Zealand Government Railways;
Indian Government Administration (Railway Board);
Swedish State Railways;
Nora Bergslags Railway Co.;
Danish State Railways;
Norwegian State Railways;
Egyptian State Railways;
Atchison, Topeka & Santa Fe Railway System, U.S.A.;
Atlantic Coast Line Railroad, U.S.A.;
New York Central System, U.S.A.;
Pennsylvania Railroad Co., U.S.A.;
Southern Railway System, Washington, U.S.A.;
Coras Iompair Eireann, Ireland.

The Oxelosund-Flen-Vastmanland Railways replied that it had similar working conditions to the Swedish State Railways and, for this reason, it was felt that detailed information would not be of general interest. Accordingly, I was directed by that Undertaking to the replies given to the Questionnaire by the Swedish State Railways.

Four Administrations replied that it was not possible for them to supply the information sought.

REPLIES OF THE RAILWAY ADMINISTRATIONS TO THE QUESTIONNAIRE.

GROUP I.

Question I. — *What is the size of your establishment (number of personnel) and how is it made up :—*

a) *according to function :*
unskilled workmen;
skilled workmen;
supervisory staff;
clerical staff;
officials;
technicians (engineers, architects, etc.).

b) *according to status :*
temporary or casuals (including apprentices);
probationary;
permanent.

Answer I :

Particulars of establishment submitted by each undertaking.

SIZE OF ESTABLISHMENT.

	British Railways	*London Transport Executive*	*East African Railways and Harbours*	*South African Railways and Harbours*	*Ceylon Government Railway*	*Victorian Government Railways*
I. Total No. of Personnel. .	601 381	51 850	49 177	179 732	23 389	28 076
(a) According to function:						
Unskilled workmen . . .		35 900	38 591	90 275	9 299	3 509
Skilled workmen		6 100	5 834	65 724	11 629	19 420
Supervisory staff.		5 150	1 414	2 646	257	689
Clerical staff	Not answered	3 550	3 042	15 983	2 132	4 056
Officials		550	63	3 853	45	45
Technicians (engineers, architects, etc.)		600	233	1 251	27	357
(b) According to status:						
Temporary or casuals including apprentices . . .		1 300	1 315	111 172	2 188	10 257
Probationary		250	100	—	—	—
Permanent		50 300	47 762	68 560	21 201	17 819

SIZE OF ESTABLISHMENT *(continued)*

	New Zealand Government Railways (*)	*Indian Government Administration (Railway Board)*	*Swedish State Railway*	*Nora Bergslags Railway Company Sweden*	*Danish State Railways*	*Norwegian State Railways*	*Egyptian State Railways*
1. Total No. of Personnel	25 542	929 335	72 259	400	29 640	28 123	60 101
(a) According to function:							
Unskilled workmen	15 814	514 184	10 315	120	16 785	Not	39 393
Skilled workmen	5 005	282 356	50 083	221	6 484	given	16 880
Supervisory staff	785		3 195	14	1 505	in	379
Clerical staff	3 673	128 984	5 838	6	3 488	form	2 197
Officials	19	2 362	2 052	34	704	desired	188
Technicians (engineers, architects, etc.)	246	1 449	776	5	674		1 064
(b) According to status: temporary or casuals including apprentices	9 481	272 406	3 809	80	9 640	8 901	19 485
Probationary	—	7 782	3 342	10	1 568	—	27
Permanent	16 061	649 147	65 108	310	18 432	19 222	40 589

(*) The figures for the New Zealand Railways include 1 694 Road Service employees.

SIZE OF ESTABLISHMENT *(continued)*.

	Atchison Topeka & Santa Fe Railway System, Chicago, U.S.A.	*Atlantic Coast Line Railway North Carolina, U.S.A.*	*New York Central System, New York U.S.A.*	*Pennsylvania Railroad Company U.S.A.*	*Southern Railway System, Washington U.S.A.*	*Coras Iompair Eireann, Ireland*
1. Total No. of Personnel	64 750	19 450	105 286	133 087	40 017	12 435
(a) According to function:						
Unskilled workmen	22 500	6 431	41 627	33 964	11 700	5 927
Skilled workmen	30 500	9 063	44 021	74 098	21 958	4 457
Supervisory staff	2 700	1 348	8 154	9 527	624	226
Clerical staff	7 800	2 182	9 632	14 551	4 890	1 374
Officials	600	322	1 144	330	590	158
Technicians (engineer, architects, etc.)	650	104	708	617	255	293
(b) According to status:						
Temporary or casuals including apprentices	No temporary employees	327 Apprentices	1 005	325	—	1 550
Probationary		—	—	—	—	—
Permanent	64 750	19 123	104 281	132 762	40 017	10 885

Question 2 :

a) *By what standards do you base your requirements for personnel?*

b) *How do you watch and control the numbers required in each of your main departments?*

c) *In the last 25 years, have your tests for deciding requirements altered? Why and in what way?*

Answer 2 :

a) All the undertakings stated they base their staff requirements on the numbers necessary to operate and maintain the system.

b) Each administration has an authorised staff establishment which may be increased to meet demands. Increases in personnel require approval by Man Power Committees or Staff and Personnel Departments and in some undertakings by Heads of main Departments. Staff requirements are controlled by budgetary allocation and by periodical inspection of statistical staff returns.

c) The tests for determining personnel requirements, generally speaking, do not show any material change over the last 25 years, with the following exceptions :— On the Government of India Railways, the tests have altered due to the introduction of the Labour Laws, e.g. revised hours of employment regulations, Liberalised Leave Rules i.e. a general improvement in leave arrangements. The Norwegian State Railways, however, indicate that its tests have altered since 1947, due to greater stability of schedules and a general improvement in the statistical material available.

Question 3. — *Do you apply the same tests to evaluate your requirements for permanent staff and for temporary staff?*

Answer 3. — All of the administrations with the exception of two apply the same tests to evaluate requirements of both permanent and temporary staff.

The Southern Railway System, Washington, U.S.A., and the Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A., do not employ temporary staff.

Question 4. — *What operating considerations or other factors give rise to the employment of temporary staff, and has such temporary employment any advantage other than that arising from economic working?*

Is there a ratio of temporary to permanent staff and, if so, how is this determined? Do the numbers given represent this ratio?

Answer 4. — The reasons given for the employment of temporary staff are : — fluctuations in traffic, renewal of Way and Works Programmes and construction and building programmes. It is generally agreed there is no advantage in the employment of temporary staff other than that arising from economic working. The Danish State Railways employ a large content of temporary staff, so that in the event of retrenchment, permanent employees would not be affected.

The flexibility of temporary staff is given as an advantage by the Victorian Government Railways, Australia, as well as providing an opportunity of assessing suitability for vacancies in the permanent establishment.

In no case is there a ratio of temporary to permanent staff.

Question 5. — *Have you observed any difficulties due to recruiting too many temporary staff from the social point of view (numerous and frequent dismissals) the effect on workmanship and the difficulty in coping with sudden demands, etc.?*

Answer 5. — All of the undertakings with the exception of the East African Railways and Harbours state that they have not experienced any difficulty, due to recruiting too many temporary staff, either from the social point of view, the effect on workman-

ship or the difficulty in coping with sudden demands, etc.

In the case of the East African Railways and Harbours, there are no difficulties experienced in the employment of European and Asian temporary staff because they form a small proportion of the total temporary staff employed. There is, however, a large turnover in the African temporary staff, and this results in difficulties in maintaining a reasonable standard of workmanship, but does not give rise to social problems.

Question 6. — *Are you obliged legally to give any priority in recruiting to war or civil invalids?*

Answer 6. — There are only two undertakings legally obliged to give any priority to War or Civil Invalids in recruiting staff, namely, British Railways and the London Transport Executive. These undertakings are required by the terms of the Disabled Persons (Employment) Act, 1944, to employ 3 % of their total staff requirements from War and Civil Invalids. The staff so recruited are, as a rule, appointed to positions of Car Park Attendant and Lift Attendant.

During the war years, 1939-1945, vacancies in the Indian Government Administration (Railway Board) were reserved for « War Service » personnel. Under the Indian Constitution, however, no discrimination can be made in recruitment to the Government services.

* * *

GROUP 2.

RECRUITMENT OF WAGES GRADES AND CLERICAL WORKERS.

Question 1. — *From what sources is staff recruited :—*

a) *unsought applications?*

b) *replies to advertisements?*

c) *State or other employment agencies?*

d) *schools, technical colleges, universities?*

e) *recommendations?*

f) *other sources than above (Please specify).*

Answer 1. — Seventeen of the undertakings recruit staff from the sources specified under *a*) to *e*) inclusive.

The Indian Government Railways and the Nora Bergslags Railways Co. Sweden, recruit staff from sources *a*), *b*) and *c*).

In addition to recruiting staff from the sources mentioned, the following methods are also adopted for recruitment from other sources *(f)* :—

New Zealand Government Railways :

Through immigration.

Danish State Railways :

Through Trade Unions.

Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A. :

Through the Unemployment Section of the U.S.A. Railroad Retirement Board.

Pennsylvania Railroad Co., U.S.A. :

Through Radio announcements.

Question 2. — *Is there within the organisation a systematic plan of recruitment? If so, does this include :—*

a) *timely forecast of vacancies?*

b) *completion of a comprehensive application form by the candidate to ascertain if he meets the necessary physical and other requirements, e.g. age, height, education, past experience, nationality, etc.?*
(Please attach copy of application form or forms in use.)

c) *the submission of a diploma or certificate or setting of examination for which a stated standard of education is laid down? (Please indicate standards required.)*

d) *a check with Police Department regarding social background?*

e) *a job specification giving the description of the job and the qualities required of the candidate to do the job properly?*

f) *a screening interview to determine the qualities and aptitudes of the applicant? By whom is the interview conducted? Please give details?*

g) *psychological tests : if psychological tests are applied, please say by whom, i.e. specially trained personnel or outside industrial psychologists? What success has attended their use?*

Answer 2 :

a) With the exception of the Nora Bergslags Railway Co. Sweden, all of the undertakings have systematic plans for recruitment which include a timely forecast of vacancies.

b) Comprehensive application forms are completed by each candidate for employment, except on the Nora Bergslags Railway Co., and the Norwegian State Railways where there is no standard application form. In the case of the Atchison, Topeka and Santa Fe Railway System, Chicago, applicants for employment as Labourers are only required to state name, date of birth, height, weight and other identification marks, Nationality and Social Security Number.

c) Details of the requirements of the various undertakings in regard to diplomas or certificates of education, are as set out hereunder :—

British Railways :

Wages Grades :

No diploma or certificates required.

Clerical Workers :

Holders of

a) the Former School Certificate;

and

b) the general Certificate of education with passes in English and Mathematics are not required to take the clerical entrants' examination.

This exception also applies to holders of the Scottish Leaving Certificate with passes in Lower English and Mathematics or Lower English and Arithmetic. Other candidates for Clerical positions must pass a standard clerical examination and obtain 50 % in Arithmetic and English and a minimum of 50 % on the whole paper.

London Transport Executive :

Wages Grades :

No set standards for admission to the Wages Grades, but Craftsmen are required to produce indentures of Apprenticeship or documentary evidence of an equivalent period of service elsewhere.

Clerical Staff :

Male clerical staff are required to hold a satisfactory General Certificate of education, Degrees, Diplomas or Technical qualifications may be required for particular positions. Female clerical staff must have a good general education and aptitude tests are given as and when necessary.

East African Railways & Harbours :

Owing to multiplicity of races employed and their different standards of development, it is not practicable to summarise the educational standards. If any specified standard is laid down for a particular grade, a candidate is required to submit a Diploma or Certificate. If he does not hold the required Diploma or Certificate, he must submit himself to examination to test his educational or technical standard.

South African Railways & Harbours :

For clerical posts, the minimum educational standards are the Junior Certificate which is equivalent to Standard VIII. (Standard VIII is two years below Matriculation and is described as the general standard of education.) There are two official languages in South Africa, English and Afrikaans, and minimum standards of proficiency are laid down in these two languages for each post in the services. There is no fixed educational standard for wages

grades but candidates must conform to a minimum standard of proficiency in speaking and writing both official languages.

Ceylon Government Railway :

Special Apprentices selected for minor supervisory positions must hold the Senior School Certificate in English, Mathematics and Physics. Clerical staff, Engine Drivers and Guards must hold the Senior School Certificate in English

Victorian Government Railways, Australia :

Educational Standards are :—

Lad Labourers	State School Seventh Grade.
Lad Porter Lad Engine Cleaner Apprentices	State School Eighth Grade.
Junior Clerk Clerk	Intermediate Certificate, University of Melbourne.
Tradesmen	Credentials of Apprenticeship.

New Zealand Government Railways :

Clerical Grades	Satisfactory completion of two years Secondary instruction.
Apprentices and Engine Cleaners	Primary School Certificate.
Junior Porters	Form One.
Junior Servicemen	Form One.
Junior Mechanician	Primary School Certificate.
Junior Labourers Tradesmen Porters Labourer, Traffic Branch Labourer Per. Way Labourer Stores Branch	Form One.
Labourer, Other Branches	Fourth Standard.

Indian Government Administration (Railway Board) :

Wages Grades :

Diploma or Certificate not required except in the case of Probationary Signallers, Ticket Collectors, Train Guards, who must have the Matriculation or its equivalent.

Clerical Workers :

Are required to possess Matriculation Certificate or its equivalent from any recognised University.

Swedish State Railways :

Clerical Staff :

Candidates must have theoretical training in addition to elementary school training.

Wages Grades :

Final elementary school certificate required with passes in handwriting, mathematics and in certain cases geography. Candidates for the Engine driving grade must have at least six months' training in an Engineering Shop (Mechanical or Electrical) and pass a special examination in handwriting and mathematics.

Nora Bergslags Railway Co. :

Not stated.

Danish State Railways :

Candidates for positions which will ultimately lead to permanent appointment are required to have at least the ordinary education acquired at a Municipal School. Where a higher standard of education is demanded, an examination certificate, Deed of Apprenticeship or similar Document must be submitted. All probationers must pass an examination in composition and arithmetic.

Norwegian State Railways :

Candidates for employment in the lower grades are required to pass an examination of Middle School standard.

Egyptian State Railways :

Clerical Grades :

Candidates must hold a Secondary Education Certificate, Part Two, or the Diploma

of the Intermediate School of Commerce or other equivalent Certificate.

Wages Grades :

Candidates for positions in the Traffic and Goods Department must submit an Educational Certificate.

Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A. :

Generally, the standard required is High School. A diploma or certificate is required or the educational standards claimed by a candidate must be verified by the authority of the school which he attended.

Atlantic Coast Line Railroad, U.S.A. :

The minimum standard required is High School.

New York Central System, U.S.A. :

Candidates must submit Diploma or Certificate of education or pass an examination for which a minimum standard of education is laid down. It is also the practice to verify educational records from the schools attended by candidates for employment.

Pennsylvania Railroad Co., U.S.A. :

Standard required for most occupations is Secondary School education.

Southern Railway System, Washington, U.S.A. :

The standards required are those of Grammar School and High School.

Coras Iompair Eireann, Ireland :

Wages Grades :

The minimum standard is the Primary School Certificate.

Clerical Grades :

Clerical staff must pass an Open Competitive Examination which is Leaving Certificate standard of the Secondary Educational Board.

d) The six following undertakings check with Police Departments regarding the social background of candidates for employment :—

Victorian Government Railways, Australia;
Indian Government Administration (Railway Board);
Egyptian State Railways;
New York Central System, New York;
Pennsylvania Railroad Co., U.S.A.;
Southern Railway System, Washington.

e) Ten of the undertakings include a job specification in their plan of recruitment :—

Ceylon Government Railway;
Victorian Government Railways, Australia;
Indian Government Administration (Railway Board);
Norwegian State Railways;
Egyptian State Railways;
Atlantic Coast Line Railroad, North Carolina, U.S.A.;
Pennsylvania Railroad Co., U.S.A.;
Southern Railway System, Washington U.S.A.;
London Transport Executive;
East African Railways and Harbours.

f) Screening interviews form part of the recruiting system of the following undertakings :—

British Railways :

Interviews by local officials.

London Transport Executive

Staff Department officials.

East African Railways and Harbours :

By heads of Departments for locally engaged staff. European staff recruited from the United Kingdom are interviewed by Crown Agents for the Colonies.

South African Railways and Harbours

Candidates for positions other than that of manual Labourer are interviewed by a Selection Committee.

Victorian Government Rlys., Australia :

Interviews are conducted by officials conversant with departmental requirements.

New Zealand Government Rlys.

Personnel Department or Departmental Heads.

Indian Government Administration (Railway Board) :

Interviews are conducted by Railway Service Commission and by Departmental Officers.

Swedish State Railways :

Staff officials.

Danish State Railways

Candidates for clerical posts are interviewed by the Chief Officer of the Staff Division.

Egyptian State Railways :

Employees Bureau and/or Heads of Departments.

Atchison, Topeka & Santa Fe Railway System, U.S.A. :

The Employing Officer.

Atlantic Coast Line Railroad, U.S.A. :

Personnel Officer and/or other officials.

New York Central System, U.S.A. :

Interviews are conducted but it is not stated by whom.

Pennsylvania Railroad Co., U.S.A. :

Employing Officer.

Southern Railway System, Washington, U.S.A. :

Heads of Departments.

Coras Iompair Eireann, Ireland :

Staff Relations Department and Head of Employing Department.

Screening interviews are not conducted by the Ceylon State Railway, Norwegian State Railways or Nora Bergslags Railway Co., Sweden.

g) Psychological tests are only applied on four of the undertakings :—

South African Railways and Harbours :

Candidates for Apprenticeship by specially trained personnel.

Danish State Railways :

Probationer Engine Drivers by qualified psychologists. Candidates for permanent appointment to all other positions in the service are subject to psychological test by specially trained staff of the undertaking.

Norwegian State Railways :

Psychological tests are applied as considered necessary by a University Graduate.

New York Central System, U.S.A. :

Where a high standard of intelligence is required, psychological tests are given by outside organisation to determine the mental rating of candidates.

Question 3. — *Is recruitment conducted by each main department of the organisation or through a central labour or personnel office? Please say under either system, what constitutes the recruitment authority and who makes final selection?*

Answer 3. — Recruitment is conducted by each main Department and final selection is made by the Chief Officer of such department in the following undertakings :—

British Railways;
Swedish State Railways;
Nora Bergslags Railway Co.;
Norwegian State Railways;
Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A.;
Atlantic Coast Line Railroad, North Carolina, U.S.A.;
Pennsylvania Railroad Co., U.S.A.;
The Southern Railway System, Washington, U.S.A.

On the remaining undertakings, recruitment is conducted in the manner shown :—

London Transport Executive :

Recruitment centres — Departmental Head makes final selection.

East African Railways and Harbours :

Local recruitment by Heads of Department who are the final authority. Appointments of Europeans to clerical and supervisory posts are subject to final decision by

the Management in the case of the more senior posts in these grades.

South African Railways and Harbours :

Central Employment Office. Final authority is vested in the selection Committee.

Ceylon Government Railway :

Minor grades by Heads of Departments, other grades by competitive examination.

Victorian Government Railways, Australia :

By the Central Employment Office and Departmental Officers.

New Zealand Government Rlys. :

Recruitment is conducted by each main department on delegated authority from Central Personnel Office, which makes final selection.

Indian Government Administration (Railway Board) :

Recruitment of Clerks, Station Masters, Guards, Ticket Collectors, Engineering Supervisory staff, etc. is performed by a Railway Service Commission. Recruitment of Artisans and semi-skilled and unskilled workers is done by Departmental Heads.

Danish State Railways :

Recruitment of Junior Clerks and office hands is carried out by the Staff division of the General Directorate, which is the highest authority (under the General Manager). The final appointment of these employees is made by the General Manager. Recruitment of temporary workers is made by the Heads of Departments.

Egyptian State Railways :

Employees Bureau or Heads of Departments and General Manager for final authority.

New York Central System, U.S.A.

Central recruiting Offices at the larger Depots. Elsewhere, Heads of Departments make final selection in all cases.

Coras Iompair Eireann, Ireland

Staff Relations Department and Head of Employing Department, in the case of all grades other than clerical. Clerical staff is recruited through Open Competitive examination. Staff Relations Officer is final authority.

Question 4. — *Is recruitment continuous or made only at certain intervals?*

Answer 4. — Recruitment in the various undertakings is continuous.

Question 5. — *What are your induction arrangements? Do they involve :—*

a) *pre-appointment training carried out after selection?*

b) *post-appointment training?*

c) *does the training course involve :—*
- *— « training on the job » only?*
- *— training at school or college run by the undertaking? What is the duration of such course?*
- *— training with other organisations?*
- *— other methods than above? If so, please specify.*

d) *giving new recruits training on company history, policy, wages, promotion, pensions, medical schemes, and amenities generally?*

e) *distribution of booklet relating to the above matters or a book of rules?*

Answer 5 :

a) Induction arrangements do not involve pre-appointment training after selection, except on the following undertakings :—

London Transport Executive;
East African Railways and Harbours;
South African Railways and Harbours;
Ceylon Government Railway;
Indian Government Administration (Railway Board);
Norwegian State Railways;
Atlantic Coast Line Railroad, North Carolina, U.S.A.

b) Post appointment training is carried out on the undermentioned undertakings:—

British Railways :

Wages Grade Employees :

Training on the job only.

Clerical Workers :

Training on the job, also courses at Schools and Colleges (duration of courses 4 to 9 weeks).

London Transport Executive :

Training on the job. Typist training in the undertaking's school; Women Machine Operators either on the job or at Schools run by Machine Suppliers.

East African Railways and Harbours :

Refresher courses held at Training Schools for Assistant Station Masters, Clerical staff and Loco. Running staff. Courses also held at Administration Training Schools. Curriculum includes some training on the job. A number of Workshop Apprentices are given leave without pay to enable them undergo a period of training with British Locomotive Builders.

South African Railways and Harbours :

Training on the job only for other than Operative Staff. Courses arranged in Commercial Colleges for Operative Staff and examination held in their particular sphere.

Ceylon Government Railway :

Training on the job only.

Indian Government Administration (Railway Board)

Refresher courses are held for Transportation staffs. Promotional courses are also held for Loco. Firemen and Shunters. There is also training on the job for all grades.

Victorian Government Rlys., Australia :

Training on the job only except in the case of Porters and Trainee Enginemen.

Porters : Courses of three months' duration.

Trainee Enginemen : A two weeks' course of Machine work.

Boy Staff generally : Courses arranged in the employees' time by the Victorian Railways Institute or the Department to cover a wide variety of subjects to assist them to qualify for promotion.

New Zealand Government Rlys. :

Training on the job only. The Department correspondence School provides free correspondence courses for Clerical, Locomotive and Communication staff. Training for Book-keeping Machinists.

Swedish State Railways :

Training courses are held for Operating Section candidates and for Engine Drivers' Assistants. Candidates in other Sections take correspondence courses for qualifying examinations.

Nora Bergslags Railway Co. :

Training on the job only.

Danish State Railways :

Junior Clerks : Six weeks' courses in Railway training centre and then training on the job; after nineteen months' service, there is a second course of thirteen weeks. On completion of this course, Junior Clerks, on passing a written examination, are promoted to the position of Sub-Clerk. Porters, Platelayers and Senior Workers are given training on the job, followed by courses at Training centres.

Norwegian State Railways :

Training on the job, half yearly training courses at Railway School.

Egyptian State Railways :

Training on the job only.

Atchison, Topeka & Santa Fe Railway System, Chicago, U.S.A. :

Training on the job only.

New York Central System, U.S.A. :

Training on the job only. Training courses for Traffic, Information and Telephone Clerks in matters connected with Passenger Traffic. Shorthand and Typing classes.

Pennsylvania Railroad Co., U.S.A. :

Training on the job only.

Southern Railway System, Washington, U.S.A. :

Training on the job and training classes within the organisation, classes being conditioned by job requirements.

Coras Iompair Eireann :

Training on the job only. Junior grade employees such as Office Messengers and Boy Porters are afforded the opportunity of attending both day and evening classes at Technical Schools to continue their education and enable them to qualify for promotion to higher posts in the service.

d) Within the following ten undertakings, the induction arrangements involve training new recruits in Company history, policy, wages, promotion, pensions, medical schemes and amenities generally :—

British Railways;
London Transport Executive;
Victorian Government Railways, Australia;
New Zealand Government Railways;
Swedish State Railways;
Danish State Railways;
Norwegian State Railways;
Atchison, Topeka and Santa Fe Railway System, U.S.A.;
Pennsylvania Railroad Co., U.S.A.;
Southern Railway System, Washington, U.S.A.

The East African Railways & Harbours propose to introduce this training on their undertaking.

The Indian Government Administration (Railway Board) notifies all alterations in Rules and Privileges to the staff in a fortnightly gazette.

e) All the undertakings concerned issue either Booklets or Rule Books.

Question 6. — *What is the probationary period, if any? Are any examinations carried on during this period? Are in certain cases pass out examinations required at the end of this period?*

Answer 6. — The probationary periods of the various undertakings, where they exist, are given hereunder :—

British Railways :

Wages Grades : No probationary period.

Clerical Workers serve a probationary period of six months. No examinations are conducted during or at the end of the probationary period.

London Transport Executive :

Wages Grades : No probationary period.

Clerical Staff : One year.

East African Railways & Harbours :

Probationary period three to six months. Students attending training schools are required to pass examinations during and on the termination of the probationary period.

South African Railways & Harbours :

Craftsmen : Probationary period 14-days.

Ceylon Government Railway :

Wages Grades : Probationary period one year.

All other Grades : Two years' probationary period. Examinations are conducted during the probationary period.

Victorian Government Railways, Australia :

No probationary period.

New Zealand Government Railways :

Male Salaried Staff : Three years.

Female Salaried Staff : Two years.

Probationer Junior Mechanician : Three years.

Probationer Mechanician : Three years.

All other grades : One year.

No examinations held during or at the end of probationary period.

Indian Government Administration (Railway Board) :

Officers directly recruited — 3 years.

Artisans : Nil.

All other staff : 1 year.

No examinations held.

Swedish State Railways :

Probationary period one year. Certain grades of employees are required to pass an examination at the end of the probationary period.

Nora Bergslags Railway Co. :

Probationary period one year. There are no examinations.

Danish State Railways :

Junior Clerks and Sub-Clerks : Three years' probation.

Clerks : Two years.

Female Office Hands : Three months.

All other grades except Craftsmen : Two years.

For Sub-Clerks, Engine Drivers, Firemen, Platelayers and Signal Workers, there are pass out examinations.

Norwegian State Railways :

One year. No examinations are held.

Egyptian State Railways :

One to two years. In the Traffic and Goods Departments, examinations are held at six monthly periods in train working and signalling.

Atchison, Topeka & Santa Fe Railway System, U.S.A. :

One to three months. Employees in the Operating Departments are required to pass an examination in the Company's Rules.

Atlantic Coast Line Railroad, U.S.A. :

Two months. An examination every three years for trainees who wish to qualify for promotion.

New York Central System, U.S.A. :

One to two months. There is a pass out examination.

Pennsylvania Railroad Co., U.S.A. :

Clerical Staff and for employees in the Telegraph and Police Departments — three months.

Southern Railway System, Washington, U.S.A. :

No probationary period.

Coras Iompair Eireann, Ireland :

There is a probationary period of six months for male and female Clerical Staff.

Question 7. — *Do replies to 1 to 6 above apply equally to :—*

a) *temporary and permanent staff ?*

b) *clerical and wage grades ?*

If not, indicate the extent to which the methods vary for the different classes of staff.

Answer 7. — The undertakings concerned indicate that their replies 1 to 6 in this Group apply equally to temporary and permanent staff.

As regards clerical and wage grades the practices of the undertakings are set out above.

Question 8. — *Do temporary or former temporary employees receive any special consideration if they apply for a permanent job ?*

Answer 8. — The undertakings employing temporary staff state that temporary or former employees are given special consideration for permanent positions provided they have rendered satisfactory service.

South African Railways and Harbours do not appoint non-Europeans to the permanent staff. Europeans are recruited temporarily and after two years are drafted into the permanent establishment.

On the Indian Government Administration (Railway Board) temporary employees do not receive any special consideration for permanent appointment in the case of the Gazetted services, i.e. services in higher posts. In all other cases, however, permanent vacancies are filled by temporary employees on the basis of seniority.

The Atchison, Topeka and Santa Fe Rail-

way System, Chicago, and Southern Railway System, Washington, do not employ temporary staff.

The reply of the New Zealand Government Railways to this question reads « Not under present conditions as there is no competition for permanent jobs ».

Question 9. — *Indicate the promotions which can take place within the wage grades before reaching supervisory level. What factors are taken into account in deciding such promotions? Is responsibility for such promotions always a departmental one?*

Can a member of the wage grades receive promotion to the clerical grade? Under what circumstances?

Answer 9 :

British Railways :

The promotional arrangements within the wage grades are the subject of Agreements with the Trade Unions. For the purpose of promotion, the grades are arranged in diagrams largely on a departmental basis and promotion is from step to step within a diagram. Vacancies carrying promotion are advertised to the staff as they arise, and the senior applicant who is considered by the Management to be suitable is selected. In the case of Footplate grades, however, the selection is entirely on the basis of seniority, provided the applicant has passed the necessary qualifying examinations.

Responsibility for promotion is a departmental one.

A wages grade employee can receive promotion to the Clerical grade although this is rather unusual. A wages grade employee with an aptitude for clerical work, who desires to be considered for a clerical post would apply to the Superior Officer and he would be considered when a suitable vacancy arose. Typical example is where a wages grade employee performing minor clerical duties such as Time-keeper or Porter at a small Station, may, on application, be promoted to the position of Station or Depot Clerk.

London Transport Executive :

The London Transport Executive's lines of promotion briefly are :—

Engine Cleaner/Fireman/Driver;
Stationman/Shunter/Guard/Motorman;
Stationman/Ticket Collector/Foreman Ticket Collector/Station Foreman;
Stationman/Signalman/Shunter/Guard/Motorman;
Shop Labourer/Semi-skilled/Craftsman/Leading Hand/Chargehand;
Carriage Cleaner/Carriage Examiner/Leading Examiner/Chargehand Examiner;
Signal Labourer/Semi-skilled Worker/Craftsman/Chargehand.

Responsibility for promotions is a departmental one

A wages grade employee can be considered for transfer to the clerical grade subject to satisfactory educational, age and health standards.

East African Railways and Harbours :

The salaried and wages structure of this Administration differs so widely to the normal structure of Railway Administration in Europe that it is not possible to summarise the promotions which can take place within the wage grades. Advancement in grade is dependent on seniority coupled with skill, efficiency and ability, but all other things being equal, seniority is the deciding factor.

The responsibility for promotion rests with the Heads of Departments.

It is not usual for a member of the wages grades to seek promotion to the clerical grade.

South African Railways and Harbours :

There are three classes in the wages grades, e.g. :

Class 2 — Class 1 — Special Class.

Advancement is dependent on the passing of an oral proficiency test and certification

that the employee concerned is considered to be efficient enough for advancement to the higher post.

Responsibility for such promotions is always a departmental one.

Wages Grade employees are not considered for promotion to the clerical grade unless in very exceptional circumstances.

Ceylon Government Railway :

Promotional steps are from Unskilled/Semi-skilled/Skilled.

A wages grade employee can obtain promotion to the clerical grades provided he has the necessary educational qualifications.

It is not stated in this Company's reply where the responsibility for promotion lies.

Victorian Government Railways, Australia :

The promotional steps are :—
Engine Cleaner/Fireman/Driver;
Labourer/Train Examiner/Under Gear Labourer/ Running Gear Labourer;
Labourer/Fettler/Lengthsman/Ganger/ Special Ganger;
Porter/Yard Porter/Shunter/Leading Shunter Signalman/Guard/Passenger Guard;
Porter/Assistant Stationmaster Stationmaster;
Labourer Skilled Labourer Storeman/ Storeman-in-charge.

Ability, suitability, record, experience and seniority are the factors considered in deciding promotions. All other things being equal, the senior applicant is selected for promotion.

Responsibility for promotion is always a departmental one.

A wages grade employee can receive promotion to the clerical grade, provided he has the necessary educational qualifications and provided he is not over the prescribed age.

New Zealand Government Railways :

Engine Cleaner/Fireman/Driver;
Porter/Traffic Assistant/Shunter/ Signalman/Storeman/Guard;
Labourer/Surfaceman/Ganger;
Labourer/Skilled Labourer/Storeman's Assistant/Storeman.

Suitability, efficiency and seniority are the factors considered when deciding on promotions.

Responsibility for making promotions is a departmental one.

A wages grade employee who has the requisite qualifications and education and who has completed five years, may on passing the clerical examination be promoted to the clerical grade.

Wages grade employees injured during the course of their employment or while on active service with the Armed Forces and who are unable to follow their ordinary occupations by reason of their injuries may also be promoted to the clerical grade.

Indian Government Administration (Railway Board) :

For Class IV staff, the promotional steps are :—

Unskilled/Semi-skilled//Skilled.

Promotions are by seniority subject to passing a trade test.

A wages grade employee can receive promotion to the clerical grade provided he satisfies the Recruiting Authority as to his qualifications.

Swedish State Railways :

The promotional steps are :—
Probationer/Extra Ordinary/Ordinary.

Efficiency and suitability are the factors taken into consideration and all things being equal, seniority decides the promotion.

Departmental Chiefs are responsible for making promotions.

A wages grade employee can receive promotion to the clerical grade if he is considered suitable. He is, however, given further training designed to equip him fully for the clerical service.

Nora Bergslags Railway Co., Sweden :

Sectionman/Stationman/Trainman/ Section Foreman/Clerk.

Seniority and record are the factors considered and decided on for promotions.

The responsibility for promotions is always a departmental one.

A wages grade employee can receive promotion to the clerical grade if he is considered suitable and competent to carry out clerical work.

Danish State Railways :

Porter/Probationer/Station Master's Helper/Chief Porter/Shunter Master/ Travelling Ticket Collector/ Luggage Master/Train Guard;
Signal Worker/Senior Signal Worker/ Deputy Signal Ganger/ Signal Ganger/ Chief Signal Ganger;
Fireman (he must be a skilled Mechanic or Locksmith)/Rail Goods Driver/ Electric Train Driver/Engine Driver.

In the lower grades such as Porter, promotion is usually based on seniority but in the higher classes, the factors are suitability and efficiency. Amongst other grades of employees, seniority, ability and experience are the factors taken into consideration.

Porters under 30 years of age, who have passed the examination for Acting Station Master, may be, on application, permitted to the course of training for Junior Clerks. Should he pass the written test set by the State Railways on completion of the course, he may be permitted to attend the Sub-Clerks' course. Twelve months after passing the Sub-Clerks' examination, his appointment as Clerk may be confirmed but in any case, not before completion of a total of five years' service.

Norwegian State Railways :

Efficiency, ability and seniority are the factors which decide promotions. Promotions are approved by a Central Council. It is not stated if a wages grade employee may, or may not enter the clerical grade.

Egyptian State Railways :

In the Mechanical Engineer's Department, the promotional steps are :—

Semi-skilled/Skilled/Super-skilled/The Distinctive Grade.

Responsibility for promotions lies with the Heads of Departments. Wages grade employees are not promoted to the clerical grade.

Atchison, Topeka & Santa Fe Railway System, U.S.A. :

In the Mechanical Groups, the promotional steps are :—

Apprentice/Mechanic/Head Workman/ Chargehand;
Helper/Journeyman/Leading Workman.

Efficiency, suitability and seniority are the factors taken into consideration for promotions and responsibility for promotions is a departmental one. A wage grade employee may be given promotion to the clerical grade but this rarely happens because an employee who changes grade automatically forfeits his service in the grade he is leaving.

Atlantic Coast Line Railroad, North Carolina, U.S.A. :

Trainman/Conductor/Fireman/ Engineer.

An applicant's general qualification for the position sought are the factors considered in making promotions. Promotions are a departmental responsibility.

A wages grade employee with the requisite qualifications can receive promotion to the clerical grade.

New York Central System, New York, U.S.A. :

Beyond stating that employees can advance from clerical grades to supervisory positions, depending on the seniority and qualifications of the applicant, the query is not fully answered.

Generally speaking, it is stated that responsibility for promotion rests with the Department.

Pennsylvania Railroad Co., U.S.A. :

Promotions are from :—

Labourer/Helper/Mechanic;
Fireman/Engineman : Brakeman/ Conductor.

It is not stated what factors decide promotions nor with whom responsibility for promotions rest.

A wages grade employee may be promoted to the clerical grade provided he is considered competent for clerical duties.

Southern Railway System, Washington, U.S.A. :

Subject to the limitations and seniority requirements of collective bargaining agreements, promotional opportunities are not limited but are based on qualifications and ability.

Responsibility for promotion rests with the Department.

Coras Iompair Eireann, Ireland :

Engine Cleaner/Fireman/Driver;
Platelayer/Ganger;
Signal Labourer/Installer/Ganger;
Goods Porter/Goods Checker/Working Foreman;
Parcels Porter/Station Ticket Collector/Travelling Ticket Collector/Guard;
Passenger Porter/Shunter/Station Foreman.

Efficiency, experience and seniority are the factors taken into consideration in deciding promotions. All other things being equal, seniority is the deciding factor.

The responsibility for promotions is a departmental one.

A wages grade employee cannot be promoted to the clerical grades, but subject to conforming to the age limits, he may enter for the competitive clerical examination.

Question 10. — *What is the procedure for advancement up the clerical scale? How are vacancies advertised? What factors are considered indeciding on promotions? Is ability or seniority regarded as the more important? Has an examination to be passed before promotion can take place?*

Answer 10. — The procedure for advancement up the clerical scale is that vacancies carrying promotion are advertised to the staff and they are filled by the process of selection.

Vacancies are advertised by way of bulletin or official circular and in the case of the Nora Bergslags Railway Co., by press advertisements on occasions. Ability is the deciding factor in making promotions but all other things being equal the senior applicant is promoted.

In the case of the Indian Government Administration (Railway Board) promotion in the lower grades is mainly on the basis of seniority but in filling vacancies in the higher classes, suitability is the deciding factor.

On the Egyptian State Railways, promotions from Class IX to Class VIII, to Class VII are decided on the basis of seniority. In making promotions from Class VII to Class VI and from Class VI to Class V, from Class V to Class IV, 15 %, 20 %, and 25 % respectively of available vacancies are filled according to merit, and the remainder according to seniority. In all cases, clerical staff must serve a minimum of four years in any class before they can be promoted.

The only organisations which provide for an examination before promotion in the clerical grades are :—

Ceylon Government Railway :

Promotion from Class 2 of clerical grades is by competitive examination within the service.

New Zealand Government Railways :

Staff required to pass a departmental examination before being eligible for promotion.

Indian Government Administration (Railway Board)

In the case of certain posts in the Accounting Department clerks are required to pass an examination before promotion. In the Clerical Grade as a whole there is an Efficiency Bar and all Clerks must pass the efficiency test before they can proceed beyond the Bar in the Salary Scale.

Norwegian State Railways .

When vacancies for promotion in the Traffic Department arise candidates for such vacancies who have not been employed in this Department for the past five years, must pass a qualifying examination.

Atlantic Coast Line Railroad, North Carolina, U.S.A. :

Employees in the train service are required to pass an examination on promotion.

Question 11. — *Are periodic re-examinations carried out in the clerical grades to assess progress? Do the most successful re-examinees receive any encouragement by way of monetary reward or otherwise? What happens to unsuccessful re-examinees?*

Answer 11. — Periodic examinations are required in the following undertakings :

the Swedish State Railways, and
the Danish State Railways.

While there are no compulsory examinations for clerical employees on the London Transport Executive, such employees are encouraged by way of monetary rewards and refunds of tuition fees to improve their standard of education.

No monetary reward is given by the Swedish State Railways. Examinees who fail their progress examination are not employed in any branch of service involving safety regulations until such time as they have been successful in their examination.

The Danish State Railways require Junior Clerks who fail to pass the qualifying examination on two occasions to leave the service.

Coras Iompair Eireann does not conduct periodical examination, but Clerical Officers must undergo an efficiency test between the third and fourth year of service, and failure may result in the Clerical Officer being required to leave the service.

Clerical Officers are encouraged to attend specially arranged courses which assist them to qualify for Membership of the Institute of Transport and they are also encouraged to attend University Courses. Those who are admitted to the Institute of Transport receive monetary rewards.

* * *

GROUP 3.

RECRUITMENT TO ADMINISTRATIVE, TECHNICAL AND SUPERVISORY GRADES.

Question 1. — *Are vacancies in :*

a) *administrative and executive grades?*

b) *technical and scientific grades?*

c) *supervisory grades?*

filled exclusively from the undertaking's personnel, or is there any recruitment from outside, such as University Graduates? If from both sources, is there any fixed proportion of one to the other?

Answer 1 :

a), b), c) Generally speaking, vacancies in the administrative, technical and supervisory grades are filled from personnel within the Organisation. In the case of technical and scientific grades, recruitment is made from personnel possessing the necessary qualifications. In the event of suitable personnel being unavailable, recourse is made to University Graduates.

The Pennsylvania Railroad Co., and the Danish State Railways, however, recruit their technical and scientific staffs wholly from accredited Engineering Schools.

In the filling of vacancies, there is no fixed ratio in any of the Organisations of administrative, technical and supervisory grades filled from inside to those from outside.

Question 2. — *Is there any method of assessing potential talent of all available personnel from whom higher positions might be filled? What does it involve?*

Answer 2. — There is no method of assessing potential talent from amongst the available personnel, other than by observation and performance.

Question 3. — *If recruitment is not exclusively from the undertaking's personnel, what is the source of supply i.e. professions, Universities, Technical Schools, etc.?*

Answer 3. — Where recruitment is not exclusively from the personnel of the undertaking, the sources of supply include Universities, Colleges, Technical Schools and through advertisements in the public Press.

Question 4. — *Is there a systematic method of selection? If so, does it include :—*

a) *a job specification of vacancies arising describing the work and the requirements needed to do it properly?*

b) *any attempt to create a pool of qualified persons to balance expected vacancies?*

c) *advertising of vacancies :*
— within the undertaking?
— outside the undertaking?

d) *utilisation of sources of information of all kinds concerning candidates?*

e) *an Interview Board, other than selection Board to assist in assessing the general merits of candidates?*

f) *is there a screening test carried out? What does it involve? Who carries out this test? Give full details.*

g) *is a psychological examination made? If so, by whom, i.e. specially trained personnel or outside industrial psychologists? What success has attended their use?*

Answer 4 :

a) All the undertakings have a systematic system of selection, with the exception of the Danish State Railways and the Nora Bergslags Railway Co., Sweden. This method in most cases includes a job specification of vacancies and the requirements needed to do it properly.

b) The following undertakings have created a pool of qualified persons to balance anticipated vacancies within their administrations :—

British Railways :

Training Schemes for Traffic apprentices and graduate civil engineers.

Victorian Government Rlys., Australia:

Scholarships to apprentices and University students to assist in qualifying for administrative and professional positions.

Indian Government Administration (Railway Board) :

Panels of selected candidates for promotion are compiled and these panels are current for one year to meet the year's requirements.

The undermentioned Organisations also aim at the creation of a pool of qualified personnel, but have not specified their methods :—

Ceylon Government Railway;
New Zealand Government Railways;
Pennsylvania Railroad Company, U.S.A.;
Atlantic Coast Line Railroad Company, U.S.A.;
Norwegian State Railways;
New York Central System, U.S.A.;
Swedish State Railways.

c) It is the general practice not to advertise outside where suitable personnel for the filling of vacancies can be secured from within the undertaking. Certain of the Railways, such as the South African Railways and Harbours, Ceylon Government Railway, the Norwegian State Railways and Swedish State Railways advertise both inside and outside the Organisation, whereas the East African Railways advertise outside only. The Pennsylvania Railroad Co. and the Atlantic Coast Line Railroad do not advertise vacancies.

d) Performances and recommendations of superiors are the primary factors in the assessment of candidates within the undertaking; for outside candidates references and qualifications which are systematically checked, are utilised.

e) The Swedish State Railways and the South African Railways are the only undertakings who state they have Interview Boards other than Selection Boards to assist in the assessment of the general merits of candidates.

f) Screening tests are carried out by London Transport Executive, East African Railways and Harbours, South African Railways and Harbours, Victorian Government Railways, Australia, Indian Government Administration (Railway Board), Danish State Railways, Egyptian State Railways, Atlantic Coast Line Railroad Company, Southern Railway System, Washington, U.S.A., and Coras Iompair Eireann, Ireland. The tests are carried out by Senior Officers either individually or acting as a Board and provide for the testing of candidates in regard to their educational and technical qualifications and ascertaining their experience, capabilities, general efficiency and aptitude.

British Railways and the Pennsylvania Railroad Co., U.S.A., conduct preliminary interviews at Colleges or Universities to ensure that only suitable potential candidates are selected.

g) No psychological examination is made by any of the organisations.

Question 5. — *When a diploma is required, how do you proceed with the selection of candidates :*

a) *according to the type of degree of the candidate ?*

b) *by means of an open competitive examination ?*

Answer 5. — From an examination of the replies received, it appears that selection is made by the type of Degree.

The Indian Government Administration (Railway Board) gives consideration to the type of Degrees held, but selection is made by interview or test. Where a Diploma is required in the case of higher positions, candidates in this undertaking are required to undergo written and oral tests. For lower grade positions in which a Diploma is required, the final selection is made on the result of interview and/or test, of assessment of technical knowledge and general suitability.

Question 6. — *Do these open competitive examinations consist of written, graphical and oral tests ? Have you provided that for certain grades written or oral tests should be set to determine not only the knowlegde of the applicants but their intellectual aptitudes and character ?*

Answer 6. — This question is not applicable on account of the fact that open competitive examinations are not held for the recruitment to administrative, technical and supervisory grades, except on the Indian Government Administration (Railway Board). The competitive examination in this administration consists of written and oral tests.

Question 7. — *On what grounds do you base your choice of either of the above tests ?*

Answer 7. — The grounds on which the diploma system is chosen is because it affords a measure of standardisation according to world wide practice. This system also indicates that the candidate possesses the particular knowlegde of the field covered by his diploma.

Question 8. — *How do you set about recruiting personnel for vacancies in junior administrative and technical positions and for which vacancies a diploma is not required ?*

Answer 8. — Vacancies in the junior-administrative and technical positions, for which positions a diploma is not required, are usually filled from within the undertaking. The selection being made on the basis of suitability, efficiency and seniority.

In the Danish State Railways and the Atchison Topeka and Santa Fe Railway

System, a diploma is required for all technical vacancies. On the East African Railways and Harbours recruitment is made by local advertisement or through the Colonial Office or through the Crown Agents for the Colonies.

Question 9. — *If you effect your recruiting by open competitive examination, are your existing personnel given priority in any way? How?*

Answer 9. — This question is not applicable because open competitive examinations are not held for the recruitment to administrative, technical and supervisory grades.

Question 10. — *On what do you base the syllabus of such examinations? Do these examinations include written, oral or graphical tests?*

Answer 10. — This question is not applicable because open competitive examinations are not held for the recruitment to junior administrative, junior technical and supervisory grades.

Question 11. — *Are promotions based on seniority or suitability? In the last case, is an examination held? What is the syllabus of this examination?*

Answer 11. — From the replies received to this query, it is clear that in practically all of the undertakings, promotions are made on the basis of suitability.

In the case of the New York Central System where the vacant junior administrative or technical post is covered by agreement with the Trade Unions, seniority is the deciding factor, but for vacancies that are not covered by this agreement, the departmental Head selects the best qualified employee. Examinations for promotions are not held.

For lower graded positions, the Indian Government Administration (Railway Board) make appointments on the basis of seniority. In the higher graded positions, suitability is the deciding factor.

Question 12. — *Is there a selection Board, and if so, does it recommend or make the appointment? Who makes the final selection?*

Answer 12. — It is indicated that the following Organisations operate a Selection Board in recruitment :—

British Railways :

Recommendation by Selection Board. Final selection by Departmental Head.

London Transport Executive :

Recommendation by Selection Board. Final decision by Departmental Head.

Ceylon Government Railway :

Recommendation by Selection Board. Final selection by General Manager.

Indian Government Administration (Railway Board) :

Non-Gazetted Posts :

Recommendation by Selection Board. Final selection by Departmental Head.

Gazetted Posts :

Selection and appointment by Ministry of Railways.

Nora Bergslags Railway Co. Sweden :

Recommendation by Selection Board. Final decision by General Manager.

Swedish State Railways :

Appointments by Selection Board.

Egyptian State Railways :

Recommendation by Selection Board. Final decision by General Manager.

Coras Iompair Eireann, Ireland :

Recommendation by Selection Board. Final decision by General Manager.

The South African Railways and Harbours have a Selection Board. Heads of the Departments are required to submit nominations to Central Offices controlled by the General Manager, with a Certificate

that each nominee has the necessary qualifications.

Nominations are made by locally appointed committees of Senior Controlling Officers. The nominees are then listed in seniority order on a schedule which is submitted to the Railway Services Commission. If there is a difference of opinion between the General Manager and the Services Commission, the matter is then passed to the Ministry of Transport for decision.

Selection Boards do not operate on the following undertakings :—

East African Railways and Harbours :

Heads of Departments make recommendation. Final decision by General Manager.

Victorian Government Railways, Australia :

Head of Department makes reccommendation. Final decision by Commissioners.

New Zealand Government Railways :

Top level appointments by Ministry of Railways. All others by General Manager.

Danish State Railways :

Heads of Departments make recommendation. Final decision by General Manager.

Norwegian State Railways :

Local recommending Officials. Final decision, Central Council.

Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A. :

Recommendation by Local Officers. Final decision by Head of Department.

Atlantic Coast Line Railroad, North Carolina, U.S.A. :

Final selection rests with Head of Department.

New York Central System, New York, U.S.A. :

Where seniority is not the deciding factor, final decision is made by the Head of the Department.

Pennsylvania Railroad Co., U.S.A. :

Recommendation and Selection by Regional Chief Officer. Final decision by Chief Officer's Panel.

The Southern Railway System, Washington, does not say if it operates a Selection Board or otherwise.

Question 13. — *Is there a training procedure? If so, does it provide pre- or post-appointment training after selection? Please give full particulars of your methods?*

Answer 13. — The organisations who indicated that there is a training procedure within their undertaking, are listed hereunder with comments as to the particular training procedure :—

British Railways :

Station Masters and Goods Agents are given post-appointment training at a Staff Training College. Graduate Civil Engineers and Traffic Apprentices, pre-appointment training.

London Transport Executive

Junior Technical (Engineering) Staff Departmental training schemes up to two years.

East African Railways & Harbours :

Civil, Mechanical and Electrical Engineering training is given to suitably qualified candidates.

South African Railways & Harbours :

Pupil Civil Engineering Draughtsmen receive training in spheres including structural bridges, architectural, permanent way, etc.

New Zealand Government Rlys. :

Selected staff are sent overseas to obtain experience of any new contemplated techniques.

Indian Government Administration (Railway Board) :

Newly appointed candidates in Class 1

service spend two years training in the Staff College at Baroka and the Divisional Workshops.

Certain training classes (Initial, Refresher, and Promotion Courses) are held in the Railway Training Schools.

Apprentice Officers to the Mechanical Department undergo training for five years.

Swedish State Railways :

Post-appointment training for Engineers and Technicians involving practice and self-study in office and traffic services work. Period of training — two years Theoretical and Practical. Personnel recruited directly from outside the undertaking, undergo more intensive training than those who have had railway experience. Special training courses are given to Supervisors in Labour methods, Staff Organisation and general railway practice.

Egyptian State Railways :

Engineer Probationers are programmed through the Workshops to study Shop operations and personnel problems.

Southern Railway System, Washington, U.S.A. :

On this system training for management has been operated extensively for a considerable time. The promotion to administrative grades is not limited to any particular group and the basic policy has been to provide on-the-job training, and also to encourage off-the-job study.

Coras Iompair Eireann, Ireland :

Apprentice Draughtsmen in the Civil Engineering Department undergo a three years training course.

* * *

GROUP 4.

APPRENTICES.

Question 1. — *Do Apprentice Training Schools exist in any of your departments and to what trades are these apprentices guided ?*

Answer 1. — The Swedish State Railways and the Southern Railway System, Washington, do not recruit Apprentices and are not, therefore, concerned with this group.

The other seventeen undertakings recruit and train their Apprentices, but Training Schools are provided only by the undermentioned :—

British Railways;
East African Railways and Harbours;
Ceylon Government Railway;
Indian Government Administration (Railway Board);
Victorian Government Railways, Australia;
Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A.;
New York Central System, New York, U.S.A.

Apprentices are guided to the following trades :—

Blacksmith
Brassfinisher
Boilermaker
Coppersmith
Coremaker
Iron Machinist
Moulder
Fitter & Turner
Plater
Mechanic
Sheetmetal Worker
Springmaker
Welder
Rivetter
Forgehammerman

Coachmaker
Coachpainter
Carpenter & Joiner
French Polisher
Patternmaker
Trimmer & Upholsterer
Wagonmaker
Wheelwright
Wood Machinist
Sailmaker
Leatherworker
Bricklayer
Plumber
Painter
Slater

Electrician
Electrical Fitter
Electro Mechanic
Electro Plater

Telegraph Apprentice

Printer

In the Indian Government Administration (Railway Board) unskilled labourers are given a four years apprenticeship to fit them for positions of skilled artisans. These apprentices are designated « trade apprentices ».

Question 2. — *What are the conditions for admission? Do children of employees receive preferential treatment?*

Answer 2. — Conditions of admission of Apprentices are as set out hereunder :

Company :	*Age Limit :*	*Educational Standard :*	*Medical Examination :*	*If Preference given to children of employees :*
British Railways. . .	Eng'rg 16 - 18	General Standard	Yes	No
London Transport Executive	Under 16	Reasonable standard of education and mechanical aptitude	Yes	Yes
East African Railways & Harbours	Admission to Training School depends on age, fitness and standard of education.		Yes	Yes
South African Railways & Harbours	Not stated	Compulsory 15 wks attendance each year	Yes	25 % of vacancies reserved for children of employees
Ceylon Government Railway	...	Sixth Standard	Yes	No
Victorian Government Railways	15 - 18 with an extension to 19 for candidates who hold either the University Leaving or Intermediate Certificate or the Intermediate Certificate of an approved Technical School	State School 8th Standard	Yes	No
New Zealand Government Railways	15 - 17	2 years Secondary School	Yes	No
Indian Government Administration (Railway Board)	Not stated	Diploma from Board of Apprenticeship training	Yes	No
Nora Bergslags Railway Co.	No special conditions	No special conditions	...	No
Norwegian State Railways	...	Elementary School Certificate	Yes	Yes, other things being equal

Company :	*Age Limit :*	*Educational Standard :*	*Medical Examination :*	*If Preference given to children of employees :*
Egyptian State Railways	14 - 16	Reasonable standard required	No	Yes
Danish State Railways	Over 14	Elementary School Certificate	Yes, and psychological test	Yes
Atchison Topeka and Santa Fe Railway System	16 - 22 with extension to 28 years for ex-members of the Armed Forces	High School	Yes	Yes
New York Central System, New York	16 - 21. An extension to 25 for ex-military personnel	. .	Yes	Yes
Pennsylvania Railroad Co.	18 - 21	Satisfactory Standard	Yes	Yes
Coras Iompair Eireann Ireland	16 - 17 1/2	Primary School Certificate or Technical School Certificate.	Yes	No

Question 3. — *How is the education of the apprentices organised? Day or night classes?*

Answer 3. — Day and night classes are arranged by the following :—

British Railways;
London Transport Executive;
Victorian Government Railways, Australia;
New Zealand Government Railways;
Indian Government Administration (Railway Board);
Norwegian State Railways;
Coras Iompair Eireann, Ireland.

Day classes are run by five undertakings :—

East African Railways and Harbours;
South African Railways and Harbours;
Ceylon Government Railway;
New York Central System, U.S.A.;
Pennsylvania Railroad Co., U.S.A.

The Danish State Railways run night classes only.

Four Companies have no classes for Apprentices and they are :—

Nora Bergslags Railways Co.;
Egyptian State Railways;
Atchison Topeka & Stanta Fe Railway System, U.S.A.;
Atlantic Coast Line Railway, North Carolina, U.S.A.

Question 4. — *What is the duration of apprenticeship and what are the arrangements for engaging them? (contract, wages, etc.).*

Answer 4. — On British Railways the duration of apprenticeship is five years for Engineering and six years for the other trades.

There is a five years period of apprentice-

ship on London Transport Executive, East African Railways and Harbours; South African Railways and Harbours; Victorian Government Railways; New Zealand Government Railways; Indian Government Administration (Railway Board); Norwegian State Railways; Egyptian State Railways; Coras Iompair Eireann.

On the South African Railways, an Apprentice who qualifies in a Trade Test on completion of the fourth year of apprenticeship may be advanced to Craftsman status.

Of the foregoing ten concerns, the London Transport Executive, East African Railways & Harbours, South African Railways and Harbours and New Zealand Government Railways have a contract or indenture.

The Indian Government Administration (Railway Board) and the Norwegian State Railways do not give any information regarding a contract or indenture, and the remaining four undertakings, i.e. British Railways, Victorian Government Railways, Egyptian State Railways and Coras Iompair Eireann do not enter into any contract with an apprentice.

On the Atchison Topeka and Santa Fe Railway System, the duration of apprenticeship is :—

Engineering trades : Four years;

Bodybuilding : Three years;

Telegraph Apprentices : Two years.

Apprentices are indentured.

The following are the practices on the other undertakings :—

Ceylon Government Railway :

Three to five years, not stated whether there is a contract.

Nora Bergslags Railway Co.

Two years. No contract.

Danish State Railways :

Four-and-a-half years. Indentured.

Atlantic Coast Line Rlys., U.S.A. :

Three years; no information as to contract supplied.

New York Central System, U.S.A. :

Four years; no contract.

Pennsylvania Railroad Co., U.S.A. :

8 Periods of 130 days; no contract.

Particulars not supplied by :—

Ceylon Government Railway;

Danish State Railways;

Norwegian State Railways;

Atlantic Coast Line Railroad. North Carolina. U.S.A.;

New York Central System, New York, U.S.A.

Question 5. — *Is there an official appointed in your organisation to supervise the selection and training of apprentices?*

Answer 5. — The following organisations have in their administrations an Appointed Official who supervises the selection and training of apprentices :—

East African Railways and Harbours;

South African Railways and Harbours;

Ceylon Government Railway;

Victorian Government Railways, Australia;

New Zealand Government Railways;

Norwegian State Railways;

Atchison Topeka & Santa Fe Railway System, U.S.A.;

New York Central System, New York, U.S.A.;

Coras Iompair Eireann, Ireland.

The remaining ten organisations have no specified official for this purpose.

APPRENTICES : RATES OF PAY.

	1st year	*2nd year*	*3rd year*	*4th year*	*5th year*	*6th year*
British Railways :						
Engineering	40 -d	51/-d	61/6d	69/-d	78/-d	
Other Trades	32 -d	40 -d	51/-d	61/-d	69/-d	78/-d
London Transport Executive	50 -d	60 -d(*)	70/-d plus bonus	80/-d	90/-d	
London Transport Executive:						
Joiner	51 4d	77/-d	96/3d	115/6d	134/9d	
Signwriter	55 -d	82/6d	113/1 ½	123/7d	144/4d	
East African Railways and Harbours	57 -d	66/-d	75/-d	84/-d	99/-d	112 -d
South African Railways and Harbours	10 ¼ d per hour	1/1 ¼ d per hour	1/4 ½ d per hour	1/8 ¾ d per hour	2/2 ¾ d per hour	
	Plus cost of living allowance					
Victorian Government Railways, Australia	90/-d	117/-d	150/-d	190/-d	235/-d	
New Zealand Government Railways	2/3 ¾ d per hour				3/9 ¾ d per hour	
Indian Government Administration (Railway Board	20 Rs. per month	25 Rs. per month	30 Rs. per month	35 Rs. per month	40 Rs. per month	
	Plus cost of living bonus of 40 Rs. and free board and lodging					
Nora Bergslags Railway Co., Sweden	30 % of standard rate of lowest grade					
Egyptian State Railways	50 M/MS per diem	100 M/MS per diem	150 M/MS per diem	200 M/MS per diem	250 M/MS per diem	
Atchison Topeka & Santa Fe Railway System, Chicago :						
Engineering	Starting $ 1.359 per hour with periodic increases to rate $ 1.647					
Other Trades	Starting $ 1.527 per hour with periodic increases to rate $ 1.707					
	Cost of living bonus of 13 cents per hour paid to all Apprentices					
Pennsylvania Railroad Company, U.S.A.	1st period $ 1.489 2nd period $ 1.519 3rd period $ 1.537 4th period $ 1.567			5th period $ 1.597 6th period $ 1.627 7th period $ 1.687 8th period $ 1.777		
Coras Iompair Eireann, Ireland	31 -d	39 6d	51 6d	65/6d	81/-d	

(*) Bonus is paid on all rates in the scale.

Question 6. — *Do apprentices have absolute priority in being taken into the permanent staff on completion of their training?*

Answer 6. — Apprentices are given priority for absorption into the permanent Establishment by the following :—

The London Transport Executive;

East African Railways and Harbours;

South African Railways and Harbours;

Ceylon Government Railway;

Victorian Government Railways;

New Zealand Government Railways;

Swedish State Railways;

Egyptian State Railways;

Atlantic Coast Line Railway;

New York Central System;

Pennsylvania Railroad Co., and the

Southern Railway System, Washington, U.S.A.

The other five organisations concerned do not afford priority to their Apprentices for absorption into their permanent staff on completion of training.

Question 7. — *Does their education aim at moulding them into tradesmen capable of tackling successfully, after a few years of experience the examination set for supervisory grades?*

Answer 7. — Eleven of the Undertakings train their Apprentices with the aim of moulding them so that they may qualify for supervisory positions having gained the necessary experience of their respective trades :—

British Railways;

East African Railways & Harbours;

South African Railways & Harbours;

Ceylon Government Railway;

Victorian Government Railways, Australia;

Indian Government Administration (Railway Board);

Norwegian State Railways;

Atchison, Topeka & Santa Fe Railway System, U.S.A.;

New York Central System, U.S.A.;

Pennsylvania Railroad Co., U.S.A.

Coras Iompair Eireann, Ireland.

The London Transport Executive, New Zealand Government Railways and Nora Bergslags Railway Company, report that their aim is to produce competent tradesmen. The Danish State Railways and Egyptian State Railways indicate they do not train their apprentices with the view of taking up supervisory positions.

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GROUP 5.

PART PLAYED BY THE MEDICAL SERVICE.

Question 1. — *What part is played by the Medical Service during your recruiting? Is its responsibility limited to the time of acceptance into service of the candidates? Or does the Medical Service play its part each time an individual is promoted? Is it applied systematically and regularly in order to examine physical aptitudes of certain individuals? Of whom and at which intervals?*

Answer 1. — All the undertakings, with the exception of the Danish State Railways have their own Medical Services and new entrants are medically examined. In most cases, the Medical Service is availed of for further examination at specific intervals or on promotion in some grades.

Particulars in these respects are shown hereafter :—

Undertaking :	*Medical examination on promotion :*	*Medical examination at specific intervals*
British Railways :	Medical History Sheets are referred to on promotion	Enginemen every three years. Certain Supervisory grades, systematically and regularly
London Transport Executive :	On promotion to Guard, Signalman, Shunter, Station Foreman or on further promotion to Motor Man or Supervisory grade	A full medical examination including eyesight tests is carried out at the age of 60 and every two years thereafter
East African Railways and Harbours :	No particulars	Certain grades subjected to eyesight tests
South African Railways and Harbours :	Trainmen, Signalmen and Shunters	Trainmen, Signalmen and Shunters are examined periodically
Ceylon Government Railway :	Some grades (not specified) examined on promotion	
Victorian Government Railways, Australia	Staff promoted to positions where safety working is involved	Staff associated with the running of trains periodically examined. Drivers and Signalmen have vision and hearing tests every two years. Physical examination every 10 years up to 45 years of age; every 5 years between 45 and 60 and annually 60 to 65. Firemen have physical examination and vision and hearing tests every 4 years
New Zealand Government Railways :	Where there is doubt as to physical condition	Vision, colour and hearing tests are made at unspecified intervals
Indian Government Administration (Railway Board)	yes	Train men, Shunters, Stationmasters, Signalmen, Locomotive, Signal and Telegraph Inspectors every three years up to 45 and annually thereafter. Staff other than the above, who are required to work in the proximity of moving vehicles - examined on attaining 45 years of age and again at 50 years of age
Swedish State Railways :	Traffic Staff and Trainmen	Traffic staff and Trainmen at ages 30 and 40 and at five year intervals thereafter.
Nora Bergslags Railway Co. Sweden	.	All staff examined every 5 years.
Norwegian State Railways	...	All employees on the safety services have periodical examinations for vision, visual colour and hearing. Employees may be examined by the Medical Officer annually.

Undertaking :	*Medical examination on promotion*	*Medical examination at specific intervals*
Egyptian State Railways	Engine Cleaners and Firemen	Traffic and Goods Staff and Enginemen every three years
Atchison Topeka & Santa Fe Railway System, Chicago U.S.A.	Brakeman to Conductor; Fireman to Locomotive Engineer	Pratically all the wages grade employees are required to undergo a vision, colour and hearing test every three years. Trainmen are required to undergo a complete physical examination every three years and annually on reaching the age of 60 years
Atlantic Coast Line Railway North Carolina, U.S.A.	...	Staff are required to undergo examination when deemed necessary
New York Central System, New York, U.S.A.	...	Train staffs have to undergo periodical examination every three years under the age of 50, every 2 years 50 to 55 and annually thereafter. All officials are periodically examined every three years where they are under 35 and annually where they are 35 or over.
	...	
Pennsylvania Railroad Company, U.S.A.	All staff on promotion.	All employees upon whose health the safety of others depend are medically examined at intervals of 2 years up to 40 years of age and at least annually thereafter
Coras Iompair Eireann. Ireland	On promotion from wages to Supervisory grade.	Periodical eyesight and colour tests for Enginemen
Southern Railway System. Washington. U.S.A.	There is no fixed policy of medical examination with respect to Non Train Service employees. In other instances where required, examinations are made before employment and periodically thereafter as is the case with all Train Service employees.	

The *Danish State Railways* has no medical service. All candidates for employment must produce satisfactory evidence of health from their own Doctors.

Question 2. — *Does the decision as to the admission or rejection of candidates rest with the Medical Service or with the Executive?*

Answer 2. — The position as to the admission or rejection of candidates rests as under on the various undertakings :—

With the Executive :	*With the Medical Service :*
British Railways, East African Railways & Harbours, South African Railways and Harbours, Ceylon Government Railway, New Zealand Government Railways, Swedish State Railways, Norwegian State Railways, Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A. New York Central System, U.S.A. Pennsylvania Railway Co., U.S.A. Coras Iompair Eireann, Ireland.	London Transport Executive, Victorian Government Railways, Australia, Indian Gorvernment Administration, (Railway Board) where it is known that a physical disability would not debar an applicant from performing his duties efficiently, the Executive may certify accordingly. Nora Bergslags Railway Co., Sweden, Egyptian State Railways, Atlantic Coast Line Railway, North Carolina, Southern Railway System, Washington.

On the *Danish State Railways* should there be any doubt as to a candidate's suitability on medical grounds, the latter is referred for examination to a Doctor selected by the Railway and his decision is final.

Question 3. — *Have you set up conditions which decide the physical requirements necessary for your various duties and above all, the physical debilities and ailments likely to debar a candidate?*

Answer 3. — All the undertakings have established standards which decide the physical requirements for the duties of the various grades, and any defects which impair physical or mental efficiency, result in the rejection of a candidate.

Question 4. — *What constitutes the medical examination?*

a) *for candidates to permanent employment?*

b) *for candidates to temporary employment?*

Does it entail, in any event, a detailed check (examination of the sensory system, of reflexes, of the heart and lungs, of the sharpness of sight, etc.)? If the medical examination is only cursory for certain forms of employment, what is the extent of such examination and in respect of what types of employment?

Answer 4. — The following thirteen undertakings have the same standard of medical examination for candidates for permanent and temporary employment :—

Victorian Government Railways, Australia;

Southern Railway System, Washington;

Pennsylvania Railroad Co., U.S.A.;

New Zealand Government Railways;

Indian Government Administration (Railway Board);

Atlantic Coast Line Railway, North Carolina;

South African Railways & Harbours;

Norwegian State Railways;

London Transport Executive;

Egyptian State Railways;

Atchison Topeka and Santa Fe Railway System, Chicago;

Swedish State Railways;

New York Central System, U.S.A.

On each of these, examination involves a detailed check and examination of heart, lungs, eyesight, hearing, colour sense and general organism. In no case is the examination cursory

On the *Nora Bergslags Railway Co., Sweden,* and the *East African Railways & Harbours,* the Medical Standard for temporary employees is not so high. These two undertakings, however, subject permanent employees to a detailed examination. On the *British Railways* and *Ceylon Government Railway* there is no examination for temporary employment but for permanent employment there is a detailed examination. On *Coras Iompair Eireann, Ireland,* medical examination of temporary staff is similar to that for permanent staff and entails a detailed examination. Candidates for appointment to permanent staff on this undertaking must undergo a radiological examination before confirmation of appointment.

On the *Danish State Railways* candidates for permanent employment must produce a certificate from their own Doctors, certifying physical fitness. Temporary employees are not recruited to furnish medical certificates.

Question 5. — *Is the medical recruiting examination carried out by a full time Medical Officer of the Administration? If not, by whom?*

Answer 5. — Medical Recruiting examinations on the various undertakings are carried out as shown hereunder :—

By Full Time Medical Officer	*By Part Time Medical Officer :*
British Railways	South African Railways & Harbours
London Transport Executive	New Zealand Government Railways
Victorian Government Railways, Australia	Swedish State Railways
Indian Government Administration (Railway Board)	Nora Bergslags Railway Co., Sweden
Egyptian State Railways	Norwegian State Railways
Atlantic Coast Line Railroad, North Carolina, U.S.A.	New York Central System, New York, U.S.A.
Pennsylvania Railroad Co., U.S.A.	Southern Railway System, Washington. U.S.A.

On the Atchison, Topeka and Santa Fe Railway System, medical examination is carried out by full time Medical Officers, but in the case of temporary staff recruited at a distance from Headquarters, they are examined by local doctors selected by the undertaking for this purpose.

The Danish State Railways have no full time or part time Medical Officers. Candidates submit a medical certificate from their own doctors when making application for employment.

On Coras Iompair Eireann, Ireland, all applicants for permanent appointment are medically examined by full time Medical Officers of the Company. Temporary staff recruited outside Headquarters are medically examined by part time Medical Officers.

Medical examination on East African Railways and Harbours is carried out by Medical Officers of the three East African Governments, who perform all medical services for the administration.

In the case of the Ceylon Government Railway, the medical recruiting examination is carried out by Government Medical Officers.

* * *

GROUP 6.

LABOUR TURNOVER.

Question 1. — *What is the annual personnel replacement rate of the undertaking under present operating conditions :*

a) *for wage grades?*

b) *for the rest of the staff?*

If possible, give variations in the rates over the last 25 years.

Answer 1. — Details of the annual replacement rate and variations in the rate over the last 25 years are shown hereafter:—

	Wages grades	*Rest of staff*	*Variations over 25 years*
British Railways	19.1 %	12.3 %	Not available
London Transport Executive	8 %	2 %	Not available
East African Railways and Harbours	Information not available		
South African Railways and Harbours	12 %	7.5 %	Not available
Ceylon Government Railway	3 %	2.5 %	None appreciable
Victorian Government Railways, Australia	Information not available		
New Zealand Government Railways	26.93 %	15.92 %	Not available prior 1946
Indian Government Administration (Railway Board)	2 %	5 %	
Swedish State Railways	4.5 %	1.6 %	Not stated
Nora Bergslags Railway Co., Sweden	30 %	20 %	Increased by 500 % over last 5 years
Danish State Railways	3.1 %	3.8 %	In numbers varied 19 in 1932 to 965 in 1951/1952
Norwegian State Railways	Statistics not available	—	
Atchison, Topeka & Santa Fe Railway System, U.S.A.	10 %	10 %	Not stated
Atlantic Coast Line Railroad. North Carolina, U.S.A	Information not available		
New York Central System, U.S.A.	2 to 2 ½ %	2 to 2 ½ %	None appreciable
Pennsylvania Railroad Co., U.S.A.	2.1 %	Not available	Not available
Southern Railway System, Washington, U.S.A.	10 %	10 %	No variation except for war years
Coras Iompair Eireann, Ireland	1 %	3 %	Not available

The Egyptian State Railways supplied certain data in connection with Traffic and Goods staff, but it is not possible to schedule it in the form required.

Question 2. — *What changes have been made in your establishment during the last 25 years?*

Answer 2. — The Victorian Government Railways, Australia, Indian Government Administration (Railway Board), Egyptian State Railways, Atlantic Coast Line Railroad, North Carolina, and Pennsylvania Railroad Co., U.S.A., supplied some data, but not sufficient for the requirements of this question.

The Norwegian State Railways and Atchison, Topeka and Santa Fe Railway System, Chicago, did not supply any information on this question.

The New York Central System, the Ceylon Government Railway and Nora Bergslags Railway Co., Sweden, report that no appreciable change has taken place in establishment in the last 25 years.

The Southern Railway System, Washington, states that the average numbers of the personnel establishment have decreased by 25 % over the last 25 years.

The following undertakings submitted particulars :—

YEAR	*British Railways*	*London Transport Executive*	*East African Railways and Harbours*	*South African Railways and Harbours*	*Swedish State Railways*	*Danish State Railways*	*Coras Iompair Eireann*	*New Zealand Government Railways*
1928	...	...	27 000	82 789	27 609	18 257	14 588	18 176
1929	...	...	...	...	...	...	14 016	...
1930	...	...	...	...	27 472	...	13 956	..
1931	...	...	...	...	...	17 502	13 328	.
1932	...	...	...	...	...	...	11 973	.
1933	...	70 500	...	...	...	...	11 917	
1934	...	...	...	...	...	16 171	12 227	.
1935	...	...	...	...	26 887	...	12 117	. .
1936	...	...	...	...	...	...	12 400	..
1937	...	...	...	...	...	...	12 148	
1938	...	...	...	...	...	15 174	11 932	
1939	...	86 000	...	...	...	15 158	12 000	
1940	...	...	...	...	33 529	15 208	11 733	.
1941	...	...	...	...	...	15 188	12 080	
1942	...	...	...	...	...	15 106	12 132	
1943	...	...	...	...	...	16 199	12 522	.
1944	...	...	...	...	...	16 639	12 608	.
1945	...	...	...	...	51 305	16 890	12 820	.
1946	...	...	...	...	...	16 894	13 701	
1947	...	...	...	...	...	17 170	14 353	
1948	641 046	...	...	...	...	18 191	14 047	...
1949	624 528	...	...	...	...	18 885	13 358	
1950	605 455	...	...	...	66 305	19 519	13 135	.
1951	599 890	...	49 000	...	67 325	19 504	13 704	
1952	601 381 Nationalisation of railways 1948 Figures not available prior to 1948	97 500 Figures include road Employees	Present Administration established in 1948	172 670	Nationalised in 1940	19 583	13 557	23 848

Question 3. — *What is the retiring age :—*

a) *obligatory (age limit);*

b) *by request (right of the individual);*

c) *by premature unfitness (average age) illness or injuries.*

Answer 3. — The retiring age on the various undertakings are shown hereafter :—

Undertaking	*(a) Obligatory age limits*	*(b) By request (right of individual)*	*(c) By premature unfitness (average age) illness or injury*
British Railways	65 years	60 years salaried staff	...
London Transport Executive	65 years male - 60 years female	60 years male - 55 years female salaried grades	Average Retirement age is 51 years
East African Railways and Harbours	55 years - Engine drivers : 50 years	45 years (temporary arrangement to 1954)	Not possible to give details
South African Railways and Harbours	60 years	Not retired at own request	50 years
Ceylon Government Railway	60 years	55 years	...
Victorian Government Railways, Australia	65 years	60 years	50 years
New Zealand Government Railways	65 years	60 years or on completion of 40 years service whichever is sooner	In the year 1950 average age 53 years
Indian Government Administration (Railway Board)	55 years	On completion of 30 years' service	...
Swedish State Railways	Lowest grade : 63 Middle grade : 65 Highest grade : 66	Lowest grade : 60 Middle grade : 63 Highest grade : 65	No figures available
Nora Bergslags Railway Co., Sweden	Retiring age is obligatory but age limit not shown	Not by request	Not stated
Danish State Railways	70 years	65 years	Not available
Norwegian State Railways	70 male - 65 female (safety service) 65 male : 60 female	3 years before retiring age	...
Egyptian state Railways	60 pensionable 65 non-pensionable	55 or after 25 years' service or at 50 years of age with 15 years' service	Not stated
Atchison, Topeka & Santa Fe Railway System, Chicago	None	60 years & over	Not stated

Undertaking	*(a) Obligatory age limits*	*(b) By request (right of individual)*	*(c) By premature unfitness (average age) illness or injury*
Atlantic Coast Line Railroad, North Carolina	70 years	65 years	...
New York Central System, New York	66 1/2 years	65 years	Not stated
Pennsylvania Railroad, Co., U.S.A.	70 years	65 with 10 years' service : 60 with 30 years' service male and female	Not stated
Southern Railway System, Washington, U.S.A.	65 years	Not by request	Not stated
Coras Iompair Eireann, Ireland	65 years - male 60 years - female	salaried grades male - 60 years female - 55 years	Not stated

Question 4. — *Are you in a position to furnish a chart showing composition of your permanent staff in age groups (from 20 to 65 years of age or more, according to the obligatory retiring age)?*

Answer 4. Details where supplied of the composition of permanent staff in age groups from 20 to 70 of age are given hereunder :

	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 and over
London Transport Executive: motor men and guards only	126	488	431	444	533	444	540	433	276	37
South African Railways and Harbours	6 777	9 765	11 996	10 725	10 049	9 710	8 674	3 864		
Victorian Government Railways. Australia	858	1 316	1 403	1 622	2 182	2 414	2 414	2 508	2 240	747
Swedish State Railways	4 600	9 100	11 300	6 100	3 500	2 100	3 000	5 500	2 000	
Nora Bergslags Railway Co., Sweden	40		73		48			101		
Danish State Railways	600	3 400	2 600	1 400	600	700	1 600	2 900	1 500	500
Coras Iompair Eireann, Ireland	621	1 164	1 448	1 117	919	889	1 422	1 521	1 343	

The following undertakings replied to the effect that they were not in a position to supply this information :—

East African Railways and Harbours;
New Zealand Government Railways;
Indian Government Administration (Railway Board);
Norwegian State Railways;
Egyptian State Railways;
Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A.;
Atlantic Coast Line Railroad, North Carolina, U.S.A.;
New York Central System, New York, U.S.A.;
Pennsylvania Railroad Co., U.S.A.;
Southern Railway System, Washington, U.S.A.

In the case of the Swedish State Railways, the figures are taken from a supplied chart and are approximate.

Question 5. — *If, during the last 25 years, you have been compelled to suspend all recruiting for a certain period, what inconveniences were experienced? How and when were these felt?*

Answer 5. — The majority of the Companies have, for one reason or another, been compelled to suspend recruiting as indicated below :

British Railways :

Recruiting suspended for short periods only during past twenty-five years and this did not cause any inconvenience.

London Transport Executive :

Recruiting was suspended for a short time in 1930, due to the depression and also between the War years 1939 to 1945. As a result, difficulty has been experienced in obtaining staff of suitable age and experience for promotion.

East African Railways and Harbours :

During the Depression, 1930 to 1932 recruitment was virtually suspended and during the War years 1939 to 1945 there was no recruitment of European and qualified staff for responsible positions. Since the war, the services have been expanding more rapidly than was expected and the problem of maintaining services at full efficiency has been a major one.

South African Railways and Harbours :

During the Depression 1930 to 1933, it was necessary to reduce the total staff employed and it was not until 1935 that the establishment reached normal proportions. It is not stated what inconvenience, if any, was caused by the suspending of recruitment.

Ceylon Government Railway :

As an economy measure, recruitment was restricted and this resulted in employees having to work longer hours.

Victorian Government Railways, Australia :

Recruiting was completely suspended during the Depression years 1929 to 1930. No inconvenience resulted from this policy, except that there was a temporary shortage of junior and trained staff for some time after recruiting was resumed.

New Zealand Government Railways :

Recruiting was suspended during the Depression years 1930 to 1935 and when war broke out in 1939 the Railways Department had to release staff for service with the Armed Forces and was unable to recruit sufficient trained personnel as replacements. The effects of the suspension of recruiting 1931 to 1935 are still evident, which is reflected in the lack of trained personnel in the group with twenty to twenty five years service. Production in the Workshops has also suffered by reason of the failure to recruit apprentices during the Depression years. The staff position has been most acute during the war and post war years due to intense competition for labour.

Indian Government Administration (Railway Board) :

Recruiting was completely suspended (1)

during Depression years 1932 to 1935 and (2) immediately after second World War and also (3) after the partition of India to absorb railway workers who migrated from Pakistan. These suspensions caused a shortage of trained staff available for promotion and increased numbers in the higher age groups.

Swedish State Railways :

Depression after World War I caused a ten years suspension of recruitment resulting in obvious inconveniences. The average age of the staff became high and even old officials had to remain in unpromoted grades.

When recruitment started again in the Autumn of 1934 the yearly number of recruits became large. This caused discontent among the last appointed employees as the possibilities of being promoted decreased, which caused perpetual demands for instituting new posts in promoted grades.

Nora Bergslags Railway Co., Sweden :

No information supplied.

Danish State Railways :

During the war years 1914-1918 the numbers of permanent employees were substantially increased to meet increased volume of traffic. After the war and during the Depression years from 1921 to 1935 there was considerable redundancy and to meet this, recruitment was stopped, but no permanent employees were discharged. In consequence there was a surplus of staff, particularly in the higher grade groups. This interrupted the normal promotional progress of Clerical Staff, which was overcome by automatic promotion on attainment of 45 years of age by these Grades, although no change in their duties or responsibilities occurred.

Norwegian State Railways :

During the 1930's, all recruiting was suspended. This resulted in acute shortage of personnel.

Egyptian State Railways :

During the Depression periods, the undertaking was compelled to suspend all recruitment. This led to shortage of trained staff in certain Departments with consequent inconvenience.

Atchison, Topeka & Santa Fe Railway System, Chicago, U.S.A. :

Recruitment was restricted in the 1930's but it is not stated if any inconvenience was experienced.

Atlantic Coast Line Railroad, North Carolina, U.S.A. :

This Company had never to suspend recruiting during the past twenty-five years.

New York Central System, New York, U.S.A. :

During the Depression years 1930 to 1937, a pool was formed of employees discharged for financial reasons and these had the prior right to recall to the service. This prevented any new recruitment except in the case of specially qualified personnel.

Pennsylvania Railroad Co., U.S.A. :

There was no suspension of recruitment during the past twenty-five years.

Southern Railway System, Washington, U.S.A. :

Complete suspension of recruitment has never occurred.

Coras Iompair Eireann, Ireland :

Recruitment suspended during the years 1932 to 1937 due to adverse financial circumstances. As an economy measure a number of higher graded posts were abolished and a number of similar positions degraded. This lessened the opportunity for promotion, which led to discontent, particularly in the Clerical Grades.

Question 6. — *Are all employees resigning the service interviewed in order to ascertain their motives for leaving the organisation ?*

Answer 6. — In the following organisations, employees resigning are interviewed to ascertain their reasons for leaving :—

London Transport Executive;
South African Railways & Harbours;
Victorian Government Railways, Australia;
New Zealand Government Railways;
Swedish State Railways;
Egyptian State Railways (Key men only);
Atchison, Topeka & Santa Fe Railway System, Chicago, U.S.A.;
Pennsylvania Railroad Co., U.S.A.;
Southern Railway System, Washington, U.S.A.

The other undertakings do not hold such an interview. The East African Railways and Harbours, where there appears to be a heavy incidence of resignations, cause special investigations to be made to ascertain the reason. The Indian Government Administration (Railway Board) states that resignations from the Railway Service are rare.

Question 7. — *Is the labour turnover examined insofar as it may reveal :*

a) *unrest in the working force?*

b) *inefficiency*
- *— due to unsatisfactory recruitment methods?*
- *— due to unsatisfactory industrial relations?*
- *— in working, due to lack of training or experience in the job?*
- *— caused by lack of interest;*

c) *economic loss by :*
- *— having to recruit and train in new employees?*
- *— inefficient working?*

Answer 7. — Twelve undertakings examine their labour turnover :

British Railways :

General control of the labour force seeks to ascertain and deal with all problems arising from the causes specified.

London Transport Executive :

Examination reveals high wastage rate has been a disturbing factor in post-war operating costs.

South African Railways and Harbours :

Conferences are held periodically with the Heads of Departments, Managements, Ministry of Transport and the Unions representing the employees to discuss matters concerning wages and conditions of the employees.

Ceylon Government Railway :

Labour turnover is examined annually and there are monthly consultations with shop representatives to examine and investigate inefficiency and economic loss.

Victorian Government Railways, Australia :

The large labour turnover in years 1946 to 1951 was due to a shortage of labour and also the attractive wages paid in other industries. The heavy recruitment and training of new employees resulted in inefficient working and economic loss.

New Zealand Government Railways :

The acute labour shortage which necessitated recruitment of larger numbers of casual workers than heretofore led to unrest, inefficient working and economic loss.

Swedish State Railways :

Unrest was caused in the labour force by reason of more attractive wages paid in other industries, although social benefits were better on the railways. Due to the shortage of labour, the Company was compelled to recruit inefficient workers, and this resulted in economic loss, accentuated by recruitment and training of new employees.

Nora Bergslags Railway Co., Sweden :

Examination reveals some unrest due to the large labour turnover. The recruiting and training of new employees leads to inefficient working and economic loss.

Egyptian State Railways :

No evidence of any unrest, inefficiency or economic loss.

Atchison, Topeka & Santa Fe Railway System, Chicago, U.S.A. :

Labour turnover frequently examined through the medium of interviewing employees leaving the service in order to ascertain weaknesses which need correction. It is recognised that economic loss and inefficiency are causes resulting from high rate of labour turnover.

Pennsylvania Railroad Co., U.S.A. :

The labour turnover is constantly under review to ascertain reasons for termination of service and all steps possible are taken to reduce the labour turnover to the minimum figure.

Southern Railways System, Washington, U.S.A. :

The labour turnover is constantly under review to deal with problems arising from the specific causes mentioned.

The following railways do not examine the labour turnover from the point of view of ascertaining whether there is unrest, inefficiency or economic loss :—

East African Railways and Harbours;
Indian Government Administration (Railway Board);
Danish State Railways;
New York Central System, New York, U.S.A.;
Norwegian State Railways;
Atlantic Coast Line Railway, North Carolina, U.S.A.;
Coras Iompair Eireann, Ireland.

Question 8. — *Do you envisage a revision of the scheme by which your personnel requirements are assessed? Do you intend to revise your method of recruitment? What are your plans? What methods do you consider worth while?*

Answer 8. — No revision is contemplated in the existing schemes for assessing personnel requirements, nor is it proposed to alter the present method of recruitment by the following railways :—

British Railways;
London Transport Executive;
East African Railways and Harbours;
South African Railways and Harbours;
Ceylon Government Railway;
Victorian Government Railways, Australia;
New Zealand Government Railways;
Indian Government Administration (Railway Board);
Swedish State Railways;
Nora Bergslags Railway Co., Sweden;
Danish State Railways;
Egyptian State Railways;
Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A.;
Atlantic Coast Line Railway, North Carolina, U.S.A.;
Coras Iompair Eireann, Ireland.

The New Zealand Government Railways indicate that with improvement of the Labour position, the Department will be more selective in its recruitment of staff. Modern developments are constantly studied with a view to introducing them where it is considered beneficial to the Administration.

The Swedish State Railways qualify their answer to this question by saying that there is, at present, practically no recruitment of staff, but that a revision of the recruitment scheme is planned.

The Norwegian State Railways have a 20 year Recruitment Plan for the grades of Trainmen and Locomotive crews which is revised every five years. For the other groups of employees, there are similar short term plans. This Administration is planning a revision of its recruitment scheme.

On the Atchison, Topeka and Santa Fe Railway System, Chicago, the recruiting system is under constant review. Pamphlets describing the duties and functions of all Departments are distributed and the Company sponsors a course of business econo-

mics at the University of Southern California for its Officers.

On the New York Central System, New York, the present recruitment methods are under constant review, and an increase in the number of Employment Offices is contemplated.

An employment manual for the guidance of employment officials was published recently.

On the Pennsylvania Railroad Co., U.S.A., recruitment methods are at present under review and it is proposed to establish a system whereby recruits will be placed in posts for which they are deemed to be best qualified. It is contemplated that this will create individual interest and the desire to make railway working a career.

It is the policy of the Southern Railway System, Washington, to introduce improved methods of recruitment continuously.

* * *

SUMMARY.

1. — Nineteen Administrations submitted particulars all of which have fixed establishments controlled by various methods such as budgetary allocations and by the scrutiny of statistical staff returns.

On the Norwegian State Railways, changes have taken place in the tests for deciding staff requirements over the last twenty five years, due to the greater stability of schedules and the availability of improved statistical material. Changes have also taken place in the Indian Government Administration (Railway Board) due to the introduction of the Labour Laws, e.g. Revised Hours of Employment Regulations, Liberalised Leave Rules, etc.

The methods for assessing temporary and permanent staff requirements are identical in all undertakings.

Broadly speaking, the reasons for the employment of temporary staff are traffic fluctuations and capital works programmes. It is generally agreed there is no advantage in the employment of temporary staff other than that arising from economic working.

The employment of temporary staff has not caused any difficulties in the social sense, but the East African Railways and Harbours have difficulty in maintaining reasonable standards of output and efficiency by reason of the large turnover in native labour.

Of the Administrations reporting, in Great Britain only, is there any legal obligation on the Railways in regard to priority of employment to war and civil invalids, as by the terms of the Disabled Persons (Employment) Act, 1944, 3 % of total staff requirements must be recruited from these sources.

During the War years, 1939/1945, vacancies in the Indian Government Administration Board were reserved for « War service » personnel. Under the Constitution, however, there can be no discrimination in recruitment to the Government service.

2. — Wages grades and Clerical workers are generally recruited through the sources :—

a) unsought applications;

b) replies to advertisements;

c) State or other Employment Agencies.

Additional sources of recruitment are :—

New Zealand Government Railways :

Through immigration.

Danish State Railways :

Through Trade Unions.

Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A. :

Through the Unemployment Section of the U.S.A. Railroad Retirement Board.

Pennsylvania Railroad Company, U.S.A. :

Through Radio announcements.

With the exception of the Nora Bergslags Railway Company and the Norwegian State Railways, all the undertakings have a stan-

dard Application for Employment Form on which comprehensive details are sought regarding age, nationality, height, education, etc.

As a general rule, a diploma or set educational standards are not required from applicants for positions in the Wages grades. Candidates, however, must conform to a minimum standard of proficiency in reading, writing and mathematics. For clerical workers, the general standard is Secondary, High School or equivalent. In Coras Iompair Eireann, Ireland, clerical positions are filled through open competitive examinations. On British Railways, candidates, who do not hold the General Certificate of Education, must pass a standard examination.

Only six of the undertakings check with the Police Departments for the purpose of ascertaining the social background of applicants for employment, these are :

Victorian Government Railways, Australia;
Indian Government Administration (Railway Board);
Egyptian State Railways;
New York Central System, New York, U.S.A.;
Pennsylvania Railroad Co., U.S.A.;
Southern Railway System, Washington, U.S.A.

The following ten Administrations include a job specification in their plan of recruitment :

Ceylon Government Railway;
Victorian Government Railways, Australia;
Indian Government Administration (Railway Board);
Norwegian State Railways;
Egyptian State Railways;
Atlantic Coast Line Railroad, North Carolina, U.S.A.;
Pennsylvania Railroad Co., U.S.A.;
Southern Railway System, Washington, U.S.A.;
London Transport Executive;
East African Railways and Harbours.

All of the undertakings, with the exception of the Ceylon Government Railway, Norwegian State Railways and the Nora Bergslags Railway Company have screening interviews to ascertain the suitability of applicants. These interviews are conducted by either of the following — a Personnel Officer, Staff Relations Officer, Heads of Departments, Staff Officials, Selection Committees.

Psychological tests are applied partially only on :

South African Railways and Harbours :

Candidates for Apprenticeship by specially trained personnel.

Danish State Railways :

Probationer Engine Drivers by qualified Psychologists. Candidates for permanent appointment to all other positions in the service are subject to psychological test by specially trained staff of the undertaking.

Norwegian State Railways :

Psychological tests are applied as considered necessary by a University Graduate.

New York Central System, U.S.A. :

Where a high standard of intelligence is required, psychological tests are given by outside organisations to determine the mental rating of candidates.

In Great Britain, Sweden, Norway and the U.S.A. the main departments arrange recruitment, the final selection being made by the head of the department concerned; elsewhere, recruitment is conducted by central employment offices, personnel offices, staff recruiting centres, Commissions and final selection may be vested in Selection Committees, the General Manager or at places remote from headquarters by departmental Heads.

In all cases recruitment is continuous.

There is pre-appointment training after selection on seven of the undertakings :—

London Transport Executive;
East African Railways & Harbours;
South African Railways & Harbours;
Ceylon Government Railway;

Indian Government Administration (Railway Board);
Norwegian State Railways;
Atlantic Coast Line Railroad, North Carolina, U.S.A.

For Wage grade employees, training is generally on the job, but on six of the undertakings, this is supplemented by courses at Training centres.

There are courses, lectures and training classes for Operating staffs on three of the Companies. Special courses for clerical grades are held in nine of the administrations.

All the administrations issue either booklets containing some details of Company history, conditions of employment, rates of pay or Rule books. In Great Britain, Australia, New Zealand, Sweden, Denmark, Norway and the U.S.A., new recruits are given training on Company history, policy, wages, promotion, pensions, medical schemes, and amenities generally.

The Southern Railway System, Washington, U.S.A., and the Victorian Government Railways are the only concerns on which no probationary period is required. On the other seventeen undertakings, the probationary periods varies from 14 days in South Africa (for Craftsmen) to 3 years for Officers recruited directly in India and for junior Clerks in Denmark. Examinations are conducted during or/and on the termination of the probationary period for certain grades in East Africa, Ceylon, Sweden, Denmark, Egypt and on the Atchison, Topeka & Santa Fe Railway System, U.S.A., and the New York Central System, U.S.A.

The same methods for the recruitment of regular staff apply to temporary staff, and equally to clerical and wages grade staffs, except in the case of six undertakings who do not require temporary employees to serve a period of probation.

Except in the case of the South African Railways, which does not appoint non-Europeans to the regular staff, all other undertakings give special consideration for permanent positions to temporary employees, provided, of course, they have rendered satisfactory service.

The promotional arrangements where they exist are so complicated that it would not be possible to give in a brief form the promotions which can take place before reaching Supervisory level.

Apart from promotions in the Footplate grades on British Railways and Coras Iompair Eireann, Ireland, and certain unspecified grades on the Southern Railway System, Washington, U.S.A., which are strictly on the basis of seniority, all other promotions in the Wage grades are made on the basis of suitability and efficiency.

The Ceylon Government Railway, Danish State Railways, and Pennsylvania Railroad Co., did not reply to the Question as to where responsibility lies for the making of promotions. On the Norwegian State Railways, promotions are made by a Central Council, and on the remaining undertakings, the responsibility for promotions rests with the Heads of Departments.

Promotion to the Clerical from the Wages grades is not possible on the Egyptian State Railways, East African Railways and Harbours, South African Railways and Harbours and Coras Iompair Eireann, Ireland, undertakings. The Norwegian State Railways did not reply to this part of the question.

On the remaining 14 undertakings, it is possible for a Wages grade employee to obtain promotion to the Clerical grade, subject to age, suitability and educational qualifications. Vacancies in the Clerical grades are advertised to the Clerical staff by way of official circular and on occasions by Press advertisements on the Nora Bergslags Railway Co.

The Indian Government Administration (Railway Board) and the Egyptian State Railways make promotions in the lower grades on the basis of seniority, and in the higher grades partly on seniority and partly on efficiency.

The factors in considering promotions are efficiency, suitability, and seniority. Sub-

ject to all other thing being equal, seniority is the deciding factor.

The Ceylon Government Railway, New Zealand Government Railways, the Indian Government Administration (Railway Board), Norwegian State Railways and Atlantic Coast Line Railroad, require certain grades of Clerical employees to pass a qualifying examination on promotion.

In Sweden and Denmark, periodical examinations are carried out in the Clerical grades. On the Danish State Railways, Junior Clerks who fail, on the second attempt, to pass the qualifying examinations are required to leave the service. The London Transport Executive and Coras Iompair Eireann, Ireland, encourage clerical employees, by way of refunds of tuition fees and monetary awards, to improve their educational standards by attending University courses or qualifying for membership of the Institute of Transport.

Clerical Officers on Coras Iompair Eireann, Ireland, undergo an efficiency test between 3rd/4th year of service, and failure to pass this test may result in the Officer being required to leave the service.

3. — As far as it is practicable vacancies in the Administrative, Technical and Supervisory grades are filled from the Undertaking's personnel, but certain positions requiring technical and scientific qualifications are filled by recruitment from Universities or accredited Engineering Schools. There is no fixed ratio of internal to outside recruitment in any Administration.

Other than observation and performance, there are no standard methods of assessing potential talent of available personnel. Where outside recruitment is resorted to, the sources of supply include — Universities, Colleges, Technical Schools and advertisements in the public Press.

All administrations, except the Danish State Railways and the Nora Bergslags Railway Co., Sweden, have systematic methods of selection and these include a job specification.

British Railways, the Victorian Government Railways, Australia, and the Indian Government Administration (Railway Board) endeavour to create pools of qualified personnel to balance against anticipated vacancies by the establishment of Scholarship Apprenticeship Schemes and Graduates Engineering Schemes, and the creation of panels of Selected candidates for promotion. In Ceylon, New Zealand, Norway, Sweden and U. S. A., the Administrations also aim at the creation of pools of qualified persons but their methods are not specified.

Broadly speaking, vacancies are not advertised outside where suitable personnel is available within the undertaking. The South African Railways and Harbours, Ceylon Government Railway, Norwegian State Railways and the Swedish State Railways advertise both inside and outside their organisations and the East African Railways and Harbours advertise outside only. The Pennsylvania Railroad Co., U.S.A. and the Atlantic Coast Line Railroad, North Carolina, U.S.A. do not advertise vacancies.

In the case of candidates within the Administration, performance of duties and recommendation of superior Officers are the primary factors for determining suitability. Outside candidates are required to submit details of qualifications and references.

None of the Administrations has an Interview Board, except the Swedish State Railways and the South African Railways and Harbours which have Selection Boards as well.

Screening tests are carried out by London Transport Executive, East African Railways and Harbours, South African Railways and Harbours, Victorian Government Railways, Australia, Indian Government Administration (Railway Board), Danish State Railways, Egyptian State Railways, Atlantic Coast Line Railroad Co., Southern Railway System, Washington, U.S.A., and Coras Iompair Eireann, Ireland.

The tests are carried out by senior officers, either individually or acting as a

Board, and involve the testing of candidates educational and technical qualifications and ascertaining their experience, capabilities, general efficiency and aptitude.

British Railways and the Pennsylvania Railroad Co., U.S.A., carry out preliminary interviews at Colleges or Universities to ensure that only suitable potential candidates are selected.

There is no psychological examination held by any Administration.

The type of degree or diploma conditions the selection of candidates.

It is not the practice to hold open competitive examinations, except in the case of the Indian Government Administration (Railway Board), in filling higher posts. The diploma system is chosen, because, it affords a measure of standardisation. It also indicates that the candidate is qualified in the field covered by his diploma.

Vacancies in junior Administrative and Technical positions, and where a diploma is not required, are usually filled from within the Administration, selection being made on the basis of suitability, efficiency and seniority. Open competitive or confined examinations are not held, except by the Indian Government Administration (Railway Board). On the Danish State Railways and the Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A., a diploma is essential for all technical posts. There are Selection Boards in Great Britain, Ceylon, India, Sweden, Egypt and Ireland, and final decision rests with the General Manager, except in Great Britain. On British Railways — the Railway Executive : in the London Transport Executive — the Head of the Department makes the final selection : in the Indian Government Administration (Railway Board) the Ministry of Railways makes final selection for Gazetted posts and the Head of Department makes final decision for non-Gazetted posts. There is also a Selection Board on the South African Railways and Harbours — final selection normally rests with General Manager, but in the event of disagreement, the matter goes to the Ministry of Transport for decision.

Of the remaining ten undertakings, nine do not operate Selection Boards and selections for positions are usually made by the Heads of Departments, the final decision resting in the case of the East African Railways and Harbours, New Zealand Government Railways and Danish State Railways with the General Manager : Victorian Government Railways, Australia — with the Commissioners; Norwegian State Railways with the Central Council. On the Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A., Atlantic Coast Line Railroad Co., North Carolina, U.S.A., and New York Central System, U.S.A., by head of Department, and on the Pennsylvania Railroad, Co., by the Chief Officers panel. The Southern Railway System, Washington, U.S.A. does not say if it operates a Selection Board or otherwise.

Post appointment training is provided by :—

British Railways;
London Transport Executive;
East African Railways and Harbours;
South African Railways and Harbours;
New Zealand Government Railways;
Indian Government Administration (Railway Board);
Swedish State Railways;
Egyptian State Railways;
Southern Railway System, Washington, U.S.A.

and covers Station Masters, Goods Agents, Junior Civil, Mechanical and Electrical Engineering staffs and Draughtsmen.

4. — All of the Administrations, except Swedish State Railways and the Southern Railway System, Washington, recruit and train Apprentices, and reports show that these employees are guided to all recognised crafts and trades.

Training Schools exist on :—
British Railways;
East African Railways and Harbours;
Ceylon Government Railway;

Victorian Government Railways, Australia;
Indian Government Administration (Railway Board);
Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A.;
New York Central System, New York, U.S.A.

The conditions for admission to Apprenticeship include — defined age limits ranging from 15 to 21 years of age, with extension for ex-members of the Armed Forces on the Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A. and the New York Central System, New York, U.S.A.

All candidates for Apprenticeship must undergo a comprehensive medical test and on the Danish State Railways, there is also a psychological test. In all cases, a good standard of education is required. Preference is given to children of employees by London Transport Executive, East African Railways and Harbours, South African Railways and Harbours, Norwegian State Railways, Egyptian State Railways, Danish State Railways, Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A., New York Central System, New York, U.S.A., and Pennsylvania Railroad Co., U.S.A.

Apprentices are educated at day classes or night classes, and in some cases both day and night classes in addition to training on the job.

Four Administrations — Nora Bergslags Railway Co., Egyptian State Railways, Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A., Atlantic Coast Line Railroad, North Carolina, have no organised educational classes for Apprentices.

The duration of apprenticeship on ten of the undertakings is five years, except, in the case of non-engineering trade Apprentices on British Railways, who must serve six years.

These undertakings are :
British Railways;
London Transport Executive;
East African Railways and Harbours;
South African Railways and Harbours;
Victorian Government Railways, Australia;
New Zealand Government Railways;
Indian Government Administration (Railway Board);
Norwegian State Railways;
Egyptian State Railways;
Coras Iompair Eireann, Ireland.

On the South African Railways and Harbours, an Apprentice, on completion of the fourth year of apprenticeship, if he qualifies in a Trade test, may be advanced to Craftsman status.

On the remaining undertakings, the period of apprenticeship varies from two to five years and is detailed in the report.

On the Indian Government Administration (Railway Board), unskilled Labourers are given a four-year apprenticeship to fit them for positions as skilled Artisans. These Apprentices are designated « Trade » apprentices as distinct from Engineering apprentices.

Apprentices are indentured on the London Transport Executive, East African Railways and Harbours, South African Railways and Harbours, New Zealand Government Railways, Danish State Railways and Atchison, Topeka and Santa Fe Railway System. There is no indenture on British Railways, Victorian Government Railways, Australia, Egyptian State Railways, Coras Iompair Eireann, Nora Bergslags Railway Co., New York Central System and Pennsylvania Railroad Co. The Ceylon Government Railway, the Indian Government Administration (Railway Board), the Norwegian State Railways and the Atlantic Coast Line Railroad did not reply to this query.

Officials who supervise the selection and training of Apprentices are attached to the following :—

East African Railways and Harbours;
South African Railways and Harbours;
Ceylon Government Railway;
Victorian Government Railways, Australia;

New Zealand Government Railways;
Norwegian State Railways;
Atchison, Topeka and Santa Fe Railway System, U.S.A.;
New York Central System, U.S.A.;
Coras Iompair Eireann, Ireland.

The other eight Organisations have no specified official supervising the selection and training of Apprentices.

The London Transport Executive, East African Railways and Harbours, South African Railways and Harbours, Ceylon Government Railway, Victorian Government Railways, New Zealand Government Railways, Egyptian State Railways, Atlantic Coast Line Railroad, New York Central System, Pennsylvania Railroad Co., confer priority on their Apprentices for absorption into the permanent staff on completion of apprenticeship.

The following undertakings mould the apprentices' training so as to fit them for supervisory positions after having gained the necessary experience of their trade :—

British Railways;
East African Railways and Harbours;
South African Railways and Harbours;
Ceylon Government Railway;
Victorian Government Railways, Australia;
Indian Government Administration (Railway Board);
Norwegian State Railways;
Atchison, Topeka and Santa Fe Railway System, U.S.A.;
New York Central System, U.S.A.;
Pennsylvania Railroad Co., U.S.A.;
Coras Iompair Eireann, Ireland.

The remaining six Administrations aim at producing competent Tradesmen only.

5. — All the Administrations, except the Danish State Railways, have their own medical services and new entrants are medically examined. In addition, various grades of employees mainly attached to the Operating grades are required to undergo periodical vision, hearing and physical test.

Decision regarding admission or rejection of candidates for employment rests with the Administrations' appropriate Executive on the following :—

British Railways;
East African Railways and Harbours;
South African Railways and Harbours;
Ceylon Government Railway;
New Zealand Government Railways;
Swedish State Railways;
Norwegian State Railways;
Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A.;
New York Central System, U.S.A.;
Pennsylvania Railroad Co., U.S.A.;
Coras Iompair Eireann, Ireland.

and with the medical service on :—

London Transport Executive;
Victorian Government Railways, Australia;
Nora Bergslags Railway Co., Sweden;
Egyptian State Railways;
Atlantic Coast Line Railroad, North Carolina, U.S.A.;
Southern Railway System, Washington, U.S.A.

On the Indian Government Administration (Railway Board), the decision normally rests with the Medical Department, but where it is known that a physical disability would not debar an applicant from performing his duties efficiently, the Executive may certify accordingly.

On the Danish State Railways should there by any doubt as to a candidate's suitability on medical grounds, the latter is referred for examination to a Doctor selected by the Railway, and his decision is final.

All the undertakings have established standards which decide the physical requirements for the duties of the various grades, and any defect which impairs physical or mental efficiency results in rejection of a candidate.

On all the undertakings, candidates for permanent employment are required to undergo an exhaustive medical examina-

tion, involving a detailed check of heart, lungs, eyesight, hearing, colour sense and general organism.

On the British Railways and Ceylon Government Railway, the Danish State Railways, temporary employees are not required to undergo medical examination. On the Nora Bergslags Railway Co., East African Railways and Harbours and Cora Iompair Eireann, the medical examination for temporary employees is not so detailed.

Nine of the undertakings have full time medical officers :—

British Railways;
London Transport Executive;
Pennsylvania Railroad Co., U.S.A.;
Victorian Government Railways, Australia;
Indian Government Administration (Railway Board);
Egyptian State Railways;
Atlantic Coast Line Railroad, North Carolina, U.S.A.;
Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A.;
Coras Iompair Eireann, Ireland,

but in the case of the Atchison, Topeka and Santa Fe Railway System, and Coras Iompair Eireann, applicants for temporary employment, recruited at points remote from headquarters, are examined by part time Medical Officers.

Medical examinations are carried out by partime Medical Officers on :

South African Railways and Harbours;
New Zealand Government Railways;
Swedish State Railways;
Nora Bergslags Railway Co., Sweden;
Norwegian State Railways;
New York Central System, New York, U.S.A.;
Southern Railway System, Washington, U.S.A.

The Danish State Railways do not employ either full time or part time Medical Officers, and candidates must submit a medical certificate from their own doctors.

On the Ceylon Government Railway, East African Railways and Harbours, medical examinations are performed by Government Medical Officers.

6. — Five of the nineteen undertakings were unable to supply particulars of the annual personnel replacement rate and for the remainder the figures are embodied in the main Report.

Data supplied regarding changes in establishment 1938-1952 is also included in the main Report, and it will be observed that only eight administrations were in a position to give any figures in regard to this.

The obligatory age limits for retirement vary from 50 years for Engine Drivers on the East African Railways and Harbours to 70 years or over on some of the American undertakings. The retiring age, by request, ranges from 45 years on the East African Railways and Harbours to 65 years on most of the other Administrations. It should be stated that the 45 years on the East African Railways and Harbours is a temporary arrangement, which will be reviewed in 1954. On the Indian Government Administration (Railway Board), employees may retire by request on completion of 30 years' service.

With regard to the average age of retirement by reason of premature unfitness, only four undertakings were in a position to reply to this question. These are :—

London Transport Executive . .	51 years
South African Railways and Harbours	50 years
Victorian Government Railways, Australia	50 years
New Zealand Government Railways	53 years

Details showing the composition of the permanent staff, where supplied, are embodied in the main Report.

In the case of the Swedish State Railways, the figures quoted are taken from a chart furnished and are approximate.

On all Administrations, except the Pennsylvania Railroad Co., U.S.A., and the Southern Railway System, Washington, U.S.A., recruitment of staff was suspended for varying periods during the depression years 1929-1934 (approximately) and in Great Britain particularly, recruitment was suspended for short intervals during the second World War. In India, recruitment was also suspended after the partition of India to permit of the absorption of Railway workers who migrated from Pakistan.

The suspension of recruiting resulted in difficulty in maintaining efficiency and finding replacements for trained staff.

In the following Organisations, employees resigning are interviewed to ascertain their reasons for leaving :—

London Transport executive;

South African Railways and Harbours;

Victorian Government Railways, Australia;

New Zealand Government Railways;

Swedish State Railways;

Egyptian State Railways (Key men only);

Atchison, Topeka and Santa Fe Railway System, Chicago, U.S.A.;

Pennsylvania Railroad Co., U.S.A.;

Southern Railway System, Washington, U.S.A.

All Administrations other than :—

East African Railways and Harbours;

Indian Government Administration (Railway Board);

Danish State Railways;

Norwegian State Railways;

Atlantic Coast Line Railroad, North Carolina, U.S.A.;

New York Central System, New York, U.S.A.;

Coras Iompair Eireann, Ireland,

examine the labour turnover, particularly with a view to ascertaining why employees leave the service and to take steps to reduce the labour turn-over to the lowest figure possible. The general opinion expressed is that a large labour turn-over gives rise to impaired efficiency and economic loss.

A revision of the existing schemes for assessing personnel requirements is contemplated on the New York Central System by increasing the number of employment offices and by the distribution of an Employment Manual for the guidance of Employment Officials.

On the Pennsylvania Railroad Co., U.S.A., it is proposed to create a system whereby recruits will be placed in posts for which they are deemed to be qualified. This it is expected will create individual interest and the desire to make railway working a career.

The Norwegian State Railways are at present planning a revision of their 20-year recruitment plan, and the Swedish State Railways are also planning a revision of their recruitment scheme. The other Administrations do not propose any alteration in their present method of recruitment, but in most cases the recruiting system is kept under constant review and modern developments are being constantly studied with a view to their adaption to the existing schemes.

[621 .33]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

16th SESSION (LONDON, 1954).

QUESTION 11.

Protection of overhead lines, substations, locomotives and motor coaches against accidents of electric nature (excess voltage, overloads, short circuits and lightning).

REPORT

(America (North and South), Australia (Commonwealth of), Burma, Ceylon, Denmark, Egypt, Finland, India, Indonesia, Irak, Iran, Republic of Ireland, New Zealand, Norway, Pakistan, South Africa, Sweden and the United Kingdom of Great Britain and Northern Ireland and the territories for whose international relations the United Kingdom is responsible),

by T. S. Pick, B. Sc. (Eng.),

Chief Electrical Engineer, London Transport Executive.

FOREWORD.

Thirty-seven Administrations were consulted. The following Administrations gave detailed information in reply to the questionnaire :

Association of American Railroads;
British Railways;
Danish State Railways;
London Transport Executive;
New Zealand Government Railways;
South African Railways;
Swedish State Railways;
Government of India (Railway Board).

The questionnaire was compiled in collaboration with Messrs. Vrielynck, Directeur du Service Traction et Matériel de la Société Nationale des Chemins de fer Vicinaux, and J. De Boeck, Ingénieur en chef au Service de la Traction et du Matériel of the same Administration.

PREFACE.

In the Introduction to the Questionnaire, it was stated that information regarding protective gear on generating plant was not required, but particulars were requested regarding the *short-circuit capacity* of the system at the Generating Stations (or point of intake) and at the various substations. This factor forms the basis upon which the performance of the protective devices depends and decides whether the various stages will function in their proper sequence.

Particulars were then requested regarding the devices installed on high-tension feeders and throughout the system, including distribution stations, substations, converting plant, contact lines and rolling stock.

The information received is dealt with in Section II, Part A.

Section I.
GENERAL.

Questions 1 to 5 are of a general nature, to assess the extent and system of electrification of the electrified railway systems. Both the questions and answers are tabulated to assist easy reference.

Administration	*Question 1* Total length of electrified system : (a) route miles; (b) miles of single track	*Question 2* Particulars of electrical system : (a) D.C. or A.C. (b) Frequency c/s; (c) Voltage	*Question 3* Voltage drop in line : (a) Average; (b) Max.	*Question 4* Distance between Substations : (a) Minim.; (b) Average; (c) Maxim.	*Question 5* Trains per hour : (a) Minim.; (b) Average; (c) Maxim.
Association of American Railroads	(a) 671 miles; (b) 2 257 miles. ...	(a) A.C.; (b) 25 c/s; (c) 11 kV.	Not stated.	(a) — (b) 10 miles; (c)	Not stated.
British Railways Southern Region	(a) 407 miles; (b) 932 miles. ...	(a) D.C.; (b) — (c) 660v.	(a) 10 %; (b) 30 %. ...	(a) 1.3 miles; (b) 3.3 miles; (c) 4.2 miles.	(a) 2; (b) 8; (c) 40.
British Railways Midland Region - Euston/Watford	(a) 38 miles; (b) 76 miles. ...	(a) D.C.; (b) — (c) 630v.	No definite limits. ...	(a) 0.85 miles; (b) 1.8 miles; (c) 3.4 miles.	(a) 6; (b) 16; (c) 38.
British Railways Midland Region - Liverpool/Southport	(a) 37 miles; (b) 87 miles. ...	(a) D.C.; (b) — (c) 630v.	No definite limits. ...	(a) 1.4 miles; (b) 2.2 miles; (c) 3.4 miles.	(a) 2; (b) 3; (c) 10.
British Railways Eastern Region - Liverpool St./Shenfield	(a) 24 miles; (b) 99 miles. ...	(a) D.C.; (b) — (c) 1 500v.	(a) 5 %; (b) 33 1/3 %. ...	(a) 3.1 miles; (b) 4.75 miles; (c) 6.0 miles.	(a) 1; (b) 7; (c) 18.
British Railways Eastern Region - Manchester/Sheffield/ Wath	(a) 75 miles; (b) 228 miles. ...	(a) D.C.; (b) (c) 1 500v.	(a) 5 %; (b) 33 1/3 %. ...	(a) 4.1 miles; (b) 5.1 miles; (c) 6.5 miles.	(a) 1; (b) 3; (c) 6.
Danish State Railways	(a) 37 miles; (b) 62 miles. ...	(a) D.C.; (b) — (c) 1 650v.	(a) 15-20 % (b) 25-30 % ...	(a) 5 miles; (b) 5.6 miles; (c) 7.1 miles.	(a) 3; (b) 9 (*) (c) 12.

Administration	*Question 1* Total length of electrified system : (a) route miles; (b) miles of single track	*Question 2* Particulars of electrical system : (a) D.C. or A.C. (b) Frequency c/s; (c) Voltage	*Question 3* Voltage drop in line : (a) Average; (b) Max.	*Question 4* Distance between Substations : (a) Minim.; (b) Average; (c) Maxim.	*Question 5* Trains per hour : (a) Minim.; (b) Average; (c) Maxim.
London Transport Executive	(a) 190 miles; (b) 415 miles.	(a) D.C.; (b) — (c) 630v.	(a) 8.75 %; (b) 28.5 %.	(a) 0.53 miles; (b) 1.73 miles; (c) 4.42 miles.	(a) 4; (b) 20; (c) 40.
New Zealand Government Railways	(a) 30.8 miles; (b) 48.75 miles.	(a) D.C.; (b) — (c) 1 600v.	(a) 10-15 %; (b) 33 %.	(a) 4.32 miles; (b) 5.14 miles; (c) 6.71 miles.	(a) 1; (b) 6 (*) (c) 12.
South African Railways	(a) 683 miles; (b) 1 388 miles.	(a) D.C.; (b) — (c) 3 000v.	(a) 8 %; (b) 20 %.	(a) 5 miles; (b) 7 miles; (c) 23 miles.	(a) 1; (b) 10 (*) (c) 40 (*)
Swedish State Railways	(a) 3 800 miles; (b) 4 250 miles.	(a) A.C.; (b) 16 2/3; (c) 16 kV.	(a) — (b) 25 %.	Not stated - some mobile.	(a) 0; (b) 10 (*) (c) 17 (*)
The Railway Board, India :					
1. Southern	(a) 18 miles; (b) 36 miles.	(a) D.C.; (b) — (c) 1 500v.	(a) 27 %; (b) 47 %.	(a) 9.25 miles; (b) 9.25 miles; (c) 9.25 miles.	(a) 5; (b) 8; (c) 10.
2. Western	(a) 37 miles; (b) 104 miles.	(a) D.C.; (b) — (c) 1 550v.	(a) 10 %; (b) 19 %.	(a) 3.5 miles; (b) 5 miles; (c) 12 miles.	(a) 6; (b) 12; (c) 24.
3. Central	(a) 185 miles; (b) 430 miles;	(a) D.C.; (b) — (c) 1 500v.	(a) 10 %; (b) 20 %;	(a) 8 miles; (b) 8 miles; (c) 13 miles.	(a) 2; (b) 25; (c) 41.

(*) Approximate, depending on service.

Section II.

POWER SUPPLY.

PART A.

Question 6. — *Items a) to e) :*

a) *High-tension voltage;*

b) *Number of phases;*

c) *Frequency;*

d) *Short-circuit capacity at Generating Station (or at intake of bulk supply);*

e) *Short-circuit capacity at each Substation.*

The replies received from each Administration are summarised hereafter :

Administration	Whether power is purchased or generated	H.T. Voltage (a) At intake; (b) As transformed for distribution	Number of Phases	Frequency cycles	Short-Circuit Capacity		
					At Generating Stns. or at points of intake	At Substations mVA	
						Maxim.	Minim.
Association of American Railroads	Purchased ...	(a) 13.2 kV.; (b) 132 kV.	3 ph. 1 ph.	60 25	No details ...	No details	. . .
British Railways Southern Region	Purchased ...	(a) 132 kV.; (b) 33 kV.	3 ph. 3 ph.	50 50	1 050 mVA. ..	558 —	— . .
British Railways Midland Region - Euston/Watford	Generated ...	(a) 11 kV.; (b) 11 kV.	3 ph. 3 ph.	50 50	500 mVA. .	350	150
British Railways Midland Region - Liverpool/Southport	Purchased ...	(a) 33 kV.; (b) 11 kV.	3 ph. 3 ph.	50 50	Less than 350 mVA.	Less than 350	Less than 150
British Railways Eastern Region - Liverpool St./Shenfield	Purchased ...	(a) — (b) 33 kV.	... 3 ph.	... 50	500 mVA. —	500 —	—
British Railways Eastern Region - Manchester/Sheffield/ Wath	Purchased ...	(a) — (b) 33 kV.	... 3 ph.	... 50	500 mVA. —	500 —	— ..
Danish State Railways	Purchased ...	(a) 30 kV.; (b) 10 kV.	3 ph. 3 ph.	50 50	200 mVA.	200	20 . .
London Transport Executive	Generated 82 % Purchased 18 %	(a) 11 kV.; (b) 11 kV. & 22 kV.	3 ph. 3 ph.	50 50	Lots Road = 1 370 mVA: Greenwich 709 mVA: Neasden 993 mVA.	800 .	80 ..
New Zealand Government Railways	Purchased ...	(a) 11 kV.; (b) 33 kV.	3 ph. 3 ph.	50 50	350 mVA. ...	100 ...	— ...

Administration	Whether power is purchased or generated	H.T. Voltage (a) At intake; (b) As transformed for distribution	Number of Phases	Frequency cycles	Short-Circuit Capacity		
					At Generating Stns. or at points of intake	At Substations mVA	
						Maxim.	Minim.
South African Railways	Purchased	No details			...	...	..
Swedish State Railways	Purchased	(a) 6.3 kV.	3 ph.	50	—	—	
	Note : M.G's. convert at each Substation to single-phase, 16 2/3-cycles, 4 kV. Transformers step up to contact line pressure of 16 kV.						
The Railway Board, India :							
1. Southern	Purchased	(a) 33 kV.;	3 ph.	50	140 mVA.	No details	...
		(b) 5 kV.	3 ph.	50	...	...	...
2. Western	Purchased	(a) 22 kV.;	3 ph.	50	950 mVA.	650	100
	...	(b) 22 kV.	3 ph.	50	...	...	...
3. Central	Generated	(a) 95 kV.;	3 ph.	50	1 000 mVA.	750	250
		(b) 95 kV.;	3 ph.	50	...	...	...
		or 22 kV.	3 ph.	50	...	...	...

From the replies summarised on the previous page, it will be seen that only three Administrations generate their own supply, and in consequence no reference is made in this report to the protection of generating plant.

Where Administrations purchase power in bulk and are responsible for its distribution to a number of substations, the high-tension arrangements vary to some extent, since in some cases the incoming supply is at a voltage suitable for the length of transmission required, whilst in other cases step-up transformers have to be installed and a higher voltage utilised on certain sections of the system, owing to the increased length of transmission. Where different voltages are used for different portions of the line, both values are included in the above table.

Protection of high-tension distribution systems.

(Writer's Note.)

The basis of all protection is the short-circuit current which is available at any fault under all normal operating conditions, and for this reason the entire system must be considered from its source.

At times of light load, when only a reduced number of generators is on load, the amount of current which can be fed to a fault at a remote part of the system may be insufficient to produce operation of the protective relays, and similarly, if a number of parallel paths can participate in carrying the fault current, the amount carried by each may again prove insufficient.

If reliable operation is to be assured at all times, it is therefore essential to relate

mark with a ×, followed by a serial number, observations which may be useful. These observations should be given at the end of the table, opposite the same mark.

Question 11. — *Columns 6 and 7. In your answer, preference should be given to international symbols or to abbreviations explained at the bottom of the table.*

Question 12. — *Column 8. Indicate, by putting a + mark, the existence of, and by 0 the absence of, these interphase transformers.*

Question 13. — *Columns 9 to 15 (protection). Answer as for Column 8.*

N.B. — *Columns 9-10 and 13-14. If there is no separate protection against overloads and against short-circuits (or against voltage surges and against lightning), underline by one common stroke the + marks of each of these pairs of columns.*

Question 14. — *Column 16 (convertor unit type). Use the following abbreviations :—*

M.G. — *motor generator set;*
Cm-n — *rotary convertors, « n » being the number of phases;*
C.P.E.n — *steel tank mercury-arc rectifiers with vacuum regeneration and water cooling, « n » being the number of phases;*
C.P.V.n — *steel tank mercury-arc rectifiers with vacuum regeneration and air cooling, « n » being the number of phases;*
C.S.V.n — *the same, but sealed, or with occasional vacuum regeneration at long i..tervals by means of normally non-operating apparatus, and air cooling;*
A-n — *glass bulb rectifiers;*
I-n — *ignitrons;*
Inv.n — *invertors*

Convertors of other types should be indicated by symbols explained at the bottom of the table.

Question 15. — *Column 17. See question 9 (transformers).*

Question 16. — *Columns 18 to 29. Answer as for questions 10 to 15.*

N.B. — *Columns 18-19 and 25-26. Same remark as for question 13.*

For the answers to the above questions, please see the attached table.

Section I.

PART C.
PARTICULAR INFORMATION.

I. — TRANSFORMERS (STEP-UP).

Question 17. — *Protection of transformers against overloads and short-circuits. Give a brief description of the protective means used, and add, if necessary, an explanatory schematic diagram.*

Answer :

Swedish State Railways.

Motor generator sets are used to transform the 6 300 volts, 3-phase, 50-cycles supply to 3 000 V or 4 000 V. single-phase, 16 2/3-cycles, after which it is stepped up by transformers to 16 000 V for transmission to the overhead contact lines. The following protection is employed :—

The single-phase transformer and generator are protected against overload and short-circuit by an over-current time delay relay.

The neutral of the transformer 4 000 V winding is earthed through a resistance and a current transformer. A highly sensitive earth current relay trips the motor generator main breakers if an earth should occur on the 4 000 V windings of the transformer or the generator.

The transformer and generator are also protected by a differential relay energised

by a current transformer in the neutral of the generator winding and by the current transformer of the 16 000 V winding of the main transformer.

Pennsylvania Railroad.

Transformers, both step-up and step-down, are protected by differential relays. Since high-tension (132 kV) circuit breakers are not provided for each transformer, it is necessary to clear the entire transmission line section for a fault within the differential zone. Auxiliary relays trip the low-tension breaker in 0.2 second after the fault occurs, and set up a circuit to trip the high-tension disconnecting switch when fault current is removed by clearing of the associated transmission line section. All transformers are equipped with temperature alarm indicators which are actuated when transformer oil temperature reaches 75° C. Step-down transformers are also provided with overload relays set at 300 % of continuous rating with timing co-ordinated with transformer thermal capacity.

TRANSFORMERS (RECTIFYING EQUIPMENT).

See question 17 above.

Answer :

The Swedish State Railways and the Pennsylvania Railroad in America both use an A.C. system, and in consequence, rectifying equipments are not installed on these two systems.

For the purpose of protection against overload and short-circuit, all the Administrations treat the transformer and rectifier as a single unit.

Overload protection.

D.C. track circuit breakers are installed by all Administrations, and excessive loads arising on any single road are therefore disconnected at the D.C. switchboard without interrupting the operation of the rectifying plant. A.C. overload relays, having an inverse definite minimum time characteristic are also installed, however, with the object of disconnecting the rectifiers and transformers from the A.C. supply in the event of sustained overloads arising from (say) a shortage of plant, or from the combined effect of increased loadings on each track, the individual values being insufficient to bring out the track breakers.

This arrangement has been adopted by all the Administrations, but its installation has now been discontinued by British Railways — Southern Region, who make the following comments :—

« Overload protection by I.d.m.t. relays is not essential, as a traction convertor equipment cannot be adequately protected by this means, due to the « peaky » nature of the load. »

Short-circuit protection.

British Railways (Eastern Region), London Transport and South African Railways state that, in addition to the relays provided for overload protection, they also install instantaneous overcurrent relays to trip the A.C. circuit breakers as rapidly as possible in the event of short-circuit, and these relays are set to operate with current values between four and six times the normal rating of the plant.

British Railways (Southern Region) say that direct acting overload trips are preferable to overload relays, due to the faster tripping of the former.

Where glass bulb rectifiers are installed, the usual practice is to eliminate the instantaneous A.C. relay and to install a fuse of the high-rupturing capacity type in each anode lead, and this arrangement is adopted by New Zealand and India (Western Section) and also by British Railways in the majority of cases where glass bulb or pumpless air-cooled rectifiers are installed. Both New Zealand and Western India have found that the protection afforded is unreliable, and in order to safeguard further the rectifiers, New Zealand Railways have been compelled to reduce the rating of the

bulbs, whilst in Western India, where total destruction of a number of bulbs has occurred, arc suppression has now been introduced.

In this connection British Railways (Southern Region) make the following comments :—

« Experience is limited to three convertors of the pumped, air-cooled type, where the fuses have been fitted with a device which trips out the A.C. breaker on a fuse blowing. This arrangement is satisfactory. If the fuses are not fitted with the O.C.B. interlock, then the convertor may be damaged by the blowing of the fuse or fuses due to the overloading of the remaining anodes.

Anode fuses are not considered necessary for pumped type convertors so long as they are provided with instantaneous overloads and reverse current high-speed D.C. breakers. They are not considered desirable, as they cause long delays in returning rectifiers to service after a fuse blows at unattended substations. Due to the necessarily high current ratings of anode fuses, the cost of replacement is high and difficult to justify. »

Anode current relays.

These devices are used by South African Railways as a means for initiating arc suppression, and they are operated from current transformers in the anode leads or in the primary winding connection of the main transformer. Under back-fire conditions, the relay operates and maintains a negative bias on the grids for two seconds, and is arranged to give three successive operations before locking out the unit if back-firing persists.

A comment made by the Eastern Region of British Railways on this subject reads as follows :—

« Taking all requirements into consideration, it would appear that for rectifiers which are formed of a number of separate vacuum enclosures, as obtains with the glass bulb type, anode fuses may be the most preferred system of protection, whilst for rectifiers which have a single vacuum enclosure, or at most four, the other two methods of protection referred to above (i. e. over-current relays or high-speed breakers) may be preferable. »

Arc suppression.

Arc suppression devices operated by instantaneous over-current relays have been installed on a number of modern equipments, and by this means each anode in succession is prevented from striking and the current is interrupted with extreme rapidity and without the operation of the A.C. circuit breaker.

Equipments of this type are in use on the Western Section of the Indian Railways, on the South African Railways ,and in some cases on the Danish State Railways, and in all cases they are reported to give completely satisfactory protection. They have also been installed comparatively recently by British Railways (Southern Region) in thirteen substations and have proved satisfactory to date.

In order to safeguard against short-circuits due to back-fire, it is necessary to interrupt any feedback of D.C. current from other units operating in parallel with the back-firing equipment, and to cover this contingency, high-speed reverse current D.C. breakers are fitted by all railways.

Question 18. — *If you use different means of protection of transformers against overloads and short-circuits, which one do you prefer, and why ?*

Answer :

See comments quoted under question 17. and also the Writer's comments in the « Conclusions » appended to this report.

Question 19 a). — *Protection of transformers against over-heating. (If necessary, give description, together with description of any devices installed to protect against failure of cooling fan or other auxiliary appliances.)*

Answer :

In view of the appliances used to protect against overload and short-circuit, additional gear to safeguard transformers against overheating is installed by only six Administrations, and the type used varies with the type of transformer.

Oil insulated transformers with natural cooling (type ON) are protected by either a contact-making thermometer or by a thermal relay, and one or other of these arrangements is used by British Railways (Liverpool Street to Shenfield Line), India (both Western and Central Sections), Denmark, South Africa and London Transport Executive.

Transformers with air-blast cooling are used in many cases by London Transport, and on these a thermal relay is installed, the sensitive element being fixed close to a resistance located in the air stream. So long as the air blast is sufficient to remove the heat generated in the resistance, the sensitive element is not affected, but should the blast fail for any reason, the temperature near the resistance increases and the thermal device operates and shuts down the unit.

Question 19 b). — *If more than one method is used, please state which you prefer, and give reasons.*

Answer :

No preference for any particular type of appliance is expressed in the replies.

Question 20 a). — *Protection of transformers against voltage surges and lightning.*

Answer :

The protection of the H.T. side of rectifier transformers against lightning or voltage surges is not normally provided by the Railway Administrations, since in many cases the H.T. supply to each substation is by buried cables. The Western Section of the Indian Railways states that :—

« No special measures are taken to protect transformers against voltage surges or lightning. Supply to three substations is by means of underground cables. The supply to the other two substations is by means of overhead transmission lines, but a length of cable is inserted between the transmission line and the substation. This length is usually about 200 yds. In the case of one substation where only a small length is provided, lightning arrestors are being provided. »

Where substations are supplied direct from an overhead H.T. system in lightning areas, surge arrestors are provided at the end of each line before connection is made to the substation, and this practice is adopted in New Zealand.

Protection of the secondary side of rectifier transformers against voltage surges is provided in some cases by the lightning arrestors on the contact lines, and these are dealt with under question 43.

Question 20 b). — *If more than one method is used, please state which you prefer, and give reasons.*

Answer :

No preference for any particular type of appliance is expressed in the replies.

Question 21 a). — *Do you protect transformers against incidents of electrical nature, other than those mentioned above? For example, protection against oil level drop or gas liberations (Buchholz relay).*

Answer :

Where oil-immersed transformers are installed, these are fitted in many cases with a Buchholz type of relay, in order to give warning of incipient faults. Their installation is also under consideration by New Zealand and British Railways state that it is their present policy to install this additional protection on future equipments.

Question 21 b). — *If more than one method is used, state which you prefer, and give reasons.*

Answer :

No preference for any particular type of appliance is expressed in the replies.

II. — STATIC CONVERTORS.

Questions 22 a) and b). — *Protection of static convertors against overloads and short circuits. Do you use protection against these incidents peculiar to convertors, i.e. distinct from those used for convertor unit transformers? If so, give brief description and explanatory diagram. If more than one method is used, state which you prefer, and give reasons.*

Answer :

As stated under question 17, it is general practice to treat the transformer rectifier as a single unit for protection against overload and short-circuit, and in consequence the answers to this question are to be found under question 17.

Question 23 a). — *Protection of static convertors against overheating. Give brief description and add explanatory diagram if necessary.*

Answer :

Where water cooled rectifiers are installed, the usual protection against overheating is by means of a thermostat in the top plate of the rectifier, and this usually serves to shut down the plant in the event of overheating but permits restarting after an effective amount of cooling has taken place. On the Danish State Railways, however, the operation of the thermostat serves to bring an additional unit into operation.

With glass rectifiers, no protection is provided against overheating, but with air-cooled steel rectifiers a thermostat is provided and usually controls the operation of the cooling fan.

Question 23 b). — *If more than one method is used, state which you prefer, and give reasons.*

Answer :

The method provided appears to be regarded as satisfactory and no preference for any particular type is expressed.

Question 24 a). — *Protection of static convertors against cooling system failures. Give brief description and add explanatory diagram if necessary.*

Answer :

Where glass bulbs are installed, protective devices to safeguard against failure of the cooling system are not provided.

On the water-cooled rectifiers installed by London Transport, overload of the water pump shuts down the entire equipment, but on other railways this precaution does not appear to be considered necessary.

On the air-cooled, pumpless type of rectifier installed by British Railways (Liverpool Street to Shenfield) and on the London Transport Executive, failure of the cooling fans shuts down the rectifier equipment and locks out. A similar arrangement appears to be adopted by India (Western Section) but the answer is not completely clear.

On the Manchester, Sheffield branch of British Railways, failure of the fans in the cooling arrangements for the high vacuum pumps operates an alarm to signal the defect.

In the event of any failure to the cooling system on rectifier equipments on the Danish State Railways the unit is automatically stopped and the next started.

Question 24 b). *If more than one method is used, state which you prefer, and give reasons.*

Answer :

Preference for one scheme rather than another is not expressed in any of the replies.

Questions 25 a) and b). — *Protection of static convertors against ignition or excitation failure. Give brief description and add explanatory diagram if necessary. If more than one method is used, state which you prefer, and give reasons.*

Answer :

Ignition is required only as a factor in the starting process, and protection against failure to ignite is therefore required only during the starting sequence. In all cases this is covered by a timing relay, and if ignition does not take place, the sequence cannot proceed and the timing relay eventually interrupts the process but allows a complete re-start to be attempted if desired.

On the New Zealand Railways, an alarm is operated if the ignition fails.

Failure of excitation.

Protection against failure of excitation is provided by only four of the Administrations and the methods used are as follows :—

British Railways (Southern Section). On steel tank, pumpless, air-cooled rectifiers, excitation failure causes the reverse current high-speed circuit breaker to open. This Administration also comments as follows :—

« Experience has shown that some form of protection is desirable. It would be better if failure of excitation gave a warning to the control room by supervisory means without shutting down the rectifier. »

India (Central Section) comment as follows :—

« If the excitation of any one of the tanks forming the unit fails, the excitation relay on that particular tank opens and de-energises one auxiliary contactor, which in turn opens out the D.C. high-speed circuit breaker of the rectifier and disconnects the tank from the D.C. busbars, and an interlock provided starts the sequence timing relay. (This is of the solenoid type of B.T.H. manufacture. This is arranged to give a time lag on the upward stroke of the plunger.) Then the ignition equipment in this particular tank comes into operation, and if excitation is re-established, the breaker re-closes after five seconds and the track is put on load. This time delay is arranged by means of a relay. If the excitation is not re-established, the sequence timing relay completes its timing and trips the high-tension oil circuit breaker and shuts down the entire equipment. »

South African Railways comment as follows :—

« No protection against ignition failure is provided, but for excitation failure a current relay is provided, which drops out if excitation current is interrupted. This is arranged to trip the unit D.C. H.S.C.B., as well as the primary supply oil circuit breaker in some cases. »

On the steel tank water-cooled units in service on the London Transport system, if the excitation current falls below a predetermined value, a relay trips the A.C. circuit breaker, putting the unit out of service, but allowing a re-start to be attempted if desired.

Excessive current in the supply to the excitation and ignition transformers trips the A.C. circuit breaker and locks the unit out of service.

Question 26 a) and b). — *Protection of static convertors against voltage surges and lightning. Give brief description and explanatory diagram if necessary. If more than one method is used, state which you prefer, and give reasons.*

Answer :

A measure of protection against surges transmitted to the equipment from overhead contact lines is provided by the surge arrestors installed on these contact lines, and these are referred to in question 43.

So far as voltage surges generated within the rectifier itself are concerned, it is usual practice to fit divertors on all anode connections. In New Zealand, these are of

the electrolytic type. On the Western Section of the Indian Railways, two types are in service — a sealed pattern being provided on glass bulb rectifiers, whilst horn gaps in series with non-inductive resistance are used with steel tank, pumpless, air-cooled rectifiers. The latter type is also used by British Railways (Manchester to Sheffield Line), India, Central Section, Danish State Railways, and on certain equipments installed by London Transport. On the steel tank, pumpless, air-cooled rectifiers, most recently installed by London Transport, thyrite resistances in series with spark gaps are used.

The arrangements used on the South African Railways are more elaborate and the description given is as follows :—

« For substations equipped with steel tank, pumped, water-cooled rectifiers, the following equipment is provided :—

i) Thyrite arrestors are connected between the anodes and neutral of the secondary winding;

ii) Surge gaps are provided between anodes and cathode;

iii) Separate surge gaps are provided between the tank, the excitation anodes and the ignition circuit and the cathode, and in the common lead between the cathode side of the gaps a relay is provided and arranged to trip the primary supply O.C.B. and unit H.S.C.B. in the event of the gaps breaking down on account of high voltage surges.

Questions 27 a) and b). — *Protection of static convertors against loss of vacuum. Give brief particulars and add explanatory diagram if necessary. If more than one method is used, state which you prefer, and give reasons.*

Answer :

On glass rectifiers and those of the steel pumpless type, protection is not provided.

On pumped rectifiers, a Pirani or other type of vacuum gauge is installed and serves to put the unit out of service should the vacuum deteriorate beyond a predetermined amount.

In Denmark, the vacuum meter is equipped with two contacts and gives a warning signal before putting the unit out of service.

In South Africa, Creed relays or, alternatively, contact-making vacuum gauges are provided. The latter have superseded the former and are preferred, as they are stated to be more reliable.

Questions 28 a) and b). — *Protection of static convertors against internal short-circuits and arc-backs. Give brief particulars and add explanatory diagram if necessary. If more than one method is used, state which you prefer, and give reasons.*

Answer :

As stated under question 17, it is general practice to treat the transformer and rectifier as a single unit for the purpose of protection against overload and short-circuit, and the replies under this heading are therefore given under question 17.

Question 29. — *Are rectifiers arranged for automatic voltage control? If so, please give details.*

Answer :

Automatic voltage control is in use on only three of the railways from whom replies have been received, although it is also under consideration by the Danish State Railways, who visualise a + or — 4 % variation to assist in load sharing between substations.

On the Western Section of the Indian Railways, and also on the South African Railways, the regulation is achieved by grid control, whilst a regulating transformer is used on the Central Section of the Indian Railways.

Where grid control is in use, different means are employed to vary the instant at which the grids become successively positive to cathode, and this is achieved by means of a small induction regulator on some units serving the Western Section of the

Indian Railways, whilst a static method employing a choke presaturated with D.C. and connected in series with a 500 ohms resistance is used with other units on this railway.

In South Africa, a torque motor geared to an induction regulator is used in some cases, whilst in others a rotary contact maker is employed. The Administration states that both systems have disadvantages but the first system is preferred.

Questions 30 a) and b). — *Do you protect static convertors against incidents of electrical nature, other than those mentioned above? If so, give brief particulars, and add explanatory diagram if necessary. If more than one method is used, state which you prefer, and give reasons.*

Answer :

On the South African Railways, an earth leakage relay is provided in the case of pumped, air-cooled equipments and becomes energised in the event of leakage current appearing in the connection between the various frames and the substation earth plates (or spikes).

Section III.

FEEDERS AND CONTACT LINES.

Question 31. — *How, as a rule, are your contact lines constituted? Please give the following particulars :—*

a) *Is the positive conductor installed overhead or at track level?*

b) *Give size of conductor or rail;*

c) *Is a separate conductor installed for the « return », or are the running rails utilised for this purpose?*

d) *Is the « return » connected to earth? If so, please indicate the method used and the number of earth connections.*

Answer to a) :

Ten Administrations employ overhead conductor systems. The remaining four Administrations, listed below, utilise a conductor rail at track level :—

British Railways : Southern Region;

British Railways : Midland Region : Euston to Watford;

British Railways : Midland Region : Liverpool to Southport;

London Transport Executive.

Answer to b) :

Details of the size of contact wires or conductor rails were provided by all Administrations and these are given in tabulated form on the next page.

Answer to c) :

Normal practice amongst the Railway Administrations is to utilise the running rails as the return conductor.

Exceptions to this are London Transport, who provide a fourth rail, which is fully insulated from earth, in order to obtain security against breakdown in deep level tubes in the event of either the positive or negative conductor rail becoming accidentally earthed. The Euston-Watford electrified line operated by the Midland Region of British Railways also provide a fourth rail as the return conductor. In the case of London Transport, the insulated return also avoids the harmful effects of electrolysis on buried water-mains and other submerged pipe-lines in the vicinity of sub-surface tunnels.

The Swedish State Railways provide an overhead return line, which is connected to the running rails at intervals of one-third of a mile. The object of this arrangement is to eliminate inductive interference in tele-communication lines.

Answer to d) :

It is not common practice to earth permanently the return conductor, but some Administrations do provide emergency earthing by means of a neon tube in the

Administration	Size of conductor or rail
The Pennsylvania Railroad, U.S.A.	Contact wire = 4/0 bronze. Catenary = 5/8"
British Railways : Southern Region	100 lb./yd. (9.81 sq. in.) or 150 lb./yd. (14.71 sq. in.)
Midland Region : Euston to Watford	106 lb./yd.
Liverpool to Southport	106 lb./yd.
British Railways : Eastern Region : Liverpool Street to Shenfield	Main catenary = 0.321 sq.in. (cu.) Auxiliary catenary = 0.191 sq.in. (cu.) Contact wire = 0.30 sq. in. (cu.)
Manchester to Sheffield	0.75 sq.in. equivalent copper.
Danish State Railways	Main catenary = 50 or 70 sq. mm (bronze) Auxiliary catenary = 95, 150, or 240 sq. mm (cu.) Contact wire = 100 or 2 × 100 sq. mm (cu.)
London Transport Executive	150 lb./yd. — open track 130 lb./yd. — deep level tube
New Zealand State Railways	Catenary = 0.25 sq.in. stranded copper Contact wire = 0.25 sq.in. cadmium copper
South African State Railways	Catenary = 0.125, 0.15, 0.25, or 0.375 sq.in. Contact wire = 0.25 sq.in.
Swedish State Railways	Catenary = 0.078 sq.in. (cu.) Contact wire = 0.124 or 0.155 sq.in. (cu.)
The Railway Board, India : Southern	The overhead contact system is at negative potential The running rails form the positive conductor
Western	Catenary = 0.375 sq.in. (cu.) Contact rail = 0.25 sq.in. (cu.)
Central	Suburban lines 0.625 sq.in. equivalent (cu.) Main lines = 1.000 sq.in. equivalent (cu.)

event of a positive short to earth. This system is used by the Western and Central Sections of the Indian Railways and on the Liverpool Street to Shenfield Line operated by the Eastern Region of British Railways.

A special case is that of the Southern Section of the Indian Railways, in which the overhead contact is at negative potential, while the running rails form the positive conductor. In this instance the rails are earthed through a resistance at each substation.

Questions 32 a) and b). — *Are the power supply feeders of your contact lines laid* i) *overhead, or* ii) *underground?*

If both methods of laying are used, does one of them prevail notably over the other? If so, please give reasons.

Answer :

The contact line feeders of the Danish State Railways are bare copper wires without any sheathing or armouring and are supported overhead by porcelain insulators on iron poles. The remaining Railway Administrations all employ cables for track feeders and these are either laid in timber or concrete troughs or buried direct in the ground.

Underground feeders.

Question 33. — *Please state :—*

a) *Number of cores;*
b) *Type of insulation;*
c) *Type of sheathing;*
d) *Type of armouring;*
e) *Cross section of conductors most usually employed;*
f) *Average length;*
g) *Maximum length;*
h) *Whether laid in ducts or buried direct in ground.*

Answers :

a) All underground feeders are, without exception, single-cored.

b) Two types of insulation are in general use, these being vulcanised rubber and paper.

c) Sheathing is normally lead, but in a few instances compound rubber is used;

d) Armoured cables are not generally used by Railway Administrations in Great Britain, although iron wire or steel tape armouring is in general use elsewhere.

e) The cross-sectional area of conductors varies considerably, depending mainly on the voltage of the railway system and the frequency of the service, so that no general answer can be given as representative of all the Railways Administrations. In general, for :—

i) 630 D.C. systems : C.S.A. is between 0.75 and 1.4 sq. in.;

ii) 1 500 D.C. systems : C.S.A. is between 0.75 and 1.00 sq. in.;

iii) 3 000 D.C. systems : C.S.A. is 0.75 sq. in.

f) and *g)* The average length of track feeders is not realistic, since lengths vary widely in any one railway system. The majority of answers to this question are in the region of 300 ft., but there are exceptions with lower and upper limits of 30 and 600 ft. respectively. The maximum length of track feeders is, in the main, approximately 1 000 ft., the exceptions to this being British Railways (Southern Region) and India (Southern Section), who gave answers of 2 300 ft. and 3 000 ft. respectively.

h) It is general practice in India, South Africa and Sweden to bury track feeder cables direct in the ground, but in all other countries from which answers were received, the normal practice is to lay such cables in timber or concrete troughs.

On London Transport Executive, in cases where the substation is some distance from the track feeding point, the cables are carried on posts and brackets.

Overhead feeders.

Question 34. — *Please state :—*

a) *Number of cores;*
b) *Type of insulation;*
c) *Type of sheathing;*
d) *Type of armouring;*
e) *Cross section of conductors most usually employed;*
f) *Average length;*
g) *Maximum length;*
h) *Method of support.*

Answer :

No replies received.

Question 35. — *Does each substation supply power to a section of your network normally isolated from the other ones, or does it operate generally in parallel with your other substations?*

Answer :

It is common practice amongst all Railway Administrations to operate substations in parallel with adjacent substations, with the exception of London Transport, who sectionalise the low-tension system into six separate sections (see question 36).

Question 36. — *In the second supposition of question 35, please give the advantages or disadvantages arising from this arrangement, together with the reason why you have abandoned parallel operation of the substations, or why you consider it unsuitable for your network.*

Answer :

This question was answered in detail by the majority of Railway Administrations and the opinions expressed show that the parallel arangement of substations is preferred, and that the advantages of this arrangement heavily outweigh the disadvantages.

The main advantages mentioned are :—

1. Failure of one substation does not interrupt supply.

2. Better voltage distribution of the system.

3. Permits wider spacing of substations, reduced losses, and more economical use of substation plant.

The corresponding disadvantages are :—

1. If a fault is adjacent to one of two parallel operating substations, the fault current at the remote end of the section may be insufficient to operate the track H.S.C.B. This difficulty seldom arises on systems where substations are closely spaced, but where this is not the case, intermediate circuit breakers may be necessary.

2. Inverted running of rotary convertors, when there is a H.T. power supply failure, where the substations are supplied from different H.T. supply systems.

3. In the special case of the fourth rail fully insulated system, as operated by London Transport, a momentary simultaneous fault, as may sometimes occur on both positive and negative poles, can give rise to considerable rise in voltage, which in turn is liable to result in the breakdown of the insulation of train equipment at points on the system remote from the fault. To minimise the likelihood of this occurrence and to restrict the disturbance to a limited section of the track, the low-tension system is sectionalised into six sections, the gaps being made at suitable substations by splitting the busbars and connecting certain units of plant to either section as desired.

Question 37. — *If you employ parallel operation of the substations, do you use any particular protective device to avoid its weaknesses? If so, please give a brief description of those devices (with schematic diagram, if necessary) and give the results of their use. If these devices are similar to those treated in one of the questions below, please give the required reference.*

Answer :

Protective devices are installed by a number of Railway Administrations against the disadvantages listed in the previous question.

Considering first the possibility of the fault current being limited by the resistance of the circuit to a value less than that of the trip setting of the track circuit breakers at the remote end of the faulty section, the Southern and Eastern Regions of British Railways and the Swedish State Railways have overcome this disadvantage by providing automatic track parallelling H.S.C.B.'s, of which the latter Administration states as follows :—

« This breaker is a combination double-pole minimum oil circuit breaker with « contraction chambers ». It is pole-mounted with two potential transformers

and one current transformer. The breaker is remote-controlled by the most adjacent substation. It also operates automatically in the following manner :—

a) If the line becomes « dead », the breaker will open automatically with a delay that can be adjusted between 0.5-5 minutes;

b) If the line voltage drops down to about 8 000 V and at the same time a current of about 200 A passes between the two feeding sections interconnected by the breaker, the latter will open immediately (in about two seconds);

c) If the normal voltage returns on both feeding sections and phase equality exists, the breaker will close automatically and the parallel operation will be restored. »

In this connection, South African Railways state as follows :—

« In order to prevent one substation feeding over a considerable distance into a fault through the busbars of adjoining substations under conditions where the fault current would be limited by the resistance of the circuit to a value less than that of the trip setting of the track circuit breaker, a relay is provided in each substation and arranged so that, in the event of all the rectifiers in a substation shutting down, that is, failure of D.C. supply from that substation, all the track H.S.C.B's. are immediately tripped. In this way the coupling between adjacent sections is automatically opened. »

Reverse feeding of rotary convertors is prevented by the Indian State Railways (Western Section) by providing a reverse current relay set to operate at 300 A. The Central Section of the same railway, who employ a regenerative braking system using inverted operated rotary convertors comment that :—

« While running inverted, if the rotary speed tends to increase over the normal synchronous speed, then overspeed devices act. Also the weakness is removed immediately by opening the 1 500 V D.C. feeder breakers feeding the section from the healthy supply substation. Thus the inverted running of rotary convertors is prevented. »

On the tunnel section of London Transport Executive, further protection is provided by means of tripping wires carried on the tunnel walls along the whole route. These enable the driver of any train to trip the circuit breakers feeding both ends of each section in the event of an emergency requiring the section to be made « dead ».

Question 38. — *If you have employed and abandoned protective means against the weaknesses of parallel operation, please give the reason why you do not use them any more.*

Answer :

This question is not applicable to any of the Railway Administrations and no answers were received.

Question 39. — *How are your feeders and contact lines protected against overloads and short circuits? Is the protection against overloads distinct from that against short circuits?*

Answer :

High-speed circuit breakers are provided by all Railway Administrations to protect feeders and contact lines against short-circuits and overloads. The degree of discrimination between overload and short-circuit protection rests largely on the type of breaker employed. New Zealand Railways, who employ latched-in type circuit breakers with plain instantaneous overload trip, comment as follows :—

« Contact lines are protected against short-circuits by high-speed breakers with instantaneous overload trips (short-circuit protection) only. No overload protection exists on the contact lines at present, but thermal overload relays are under consideration. »

The majority of Railway Administrations

employ breakers of the high-speed magnetically held type, which depend on discrimination between overload and short-circuits by the « rate of rise » feature giving lower tripping values for high rates of rise of current. The Eastern Region of British Railways comment as follows :—

« The feeders and contact lines are protected against short-circuit by magnetically held overload trip high-speed D.C. circuit breakers with drooping voltage characteristic. No protection is provided against short time overloads, except as may be directly provided by the O.C.B. controlling the rectifier equipment in the substation. »

Question 40. — *Are devices installed to indicate the temperature of the feeders? If so, please give details.*

Answer :

London Transport is the only Administration who employ any form of device to indicate the temperature of feeders. A temperature indicator in the form of a capsule of fusible alloy is attached to the cable by means of a suitable clip. The alloy melts at a temperature of 158° F. and the indicators are examined from time to time by the Maintenance Staff, who are therefore able to give warning of any tendency for cables to become unduly hot, so that arrangements can be made to avoid a dangerous condition arising.

Question 41. — *If you use line circuit breakers, are they re-closed :—*

a) *manually?*
b) *by remote control?*
c) *automatically?*

For the first two cases, please indicate by what criterion the re-closing is decided upon.

For the third case, give the same information, adding a brief description and a schematic diagram of the re-close controlling device.

Answer :

Line circuit breakers are re-closed manually only in attended substations. The majority of rectifier substations are unattended, and in consequence the re-closing of circuit breakers is normally performed either automatically or by remote control under the direction of a central control officer. Automatic operation is employed by four Administrations and remote control by nine Administrations.

There is considerable diversity in the arrangements adopted by the various Administrations in regard to the time intervals permitted for re-closing. In the main, however, the first re-closing follows immediately after the first interruption. If a second opening takes place immediately, the second re-closing is usually delayed by a period which varies from 15 seconds to 5 minutes. If the breaker opens immediately for a third time, re-closing is then delayed for a longer period, which varies between one to ten minutes, depending on the particular condition under which the system is operated and the requirements of the location. Should the breaker again fail to remain closed, the incident is reported to the control centre and no further attempt is made to restore the supply until instructions are received.

In South Africa, at new substations, automatic re-closing will be provided to re-close three times at intervals of five seconds, and will then lock-out if the fault persists. Reset of the automatic relay will be remotely controlled from the nearest signal cabin under the direction of the central control officer.

The Danish and Swedish State Railways employ a test breaker with series resistance in parallel with the main H.S.C.B., whose duty is to test the circuit and to prevent the main breaker from closing until the current is below some predetermined value, thus saving the main breaker from repeatedly closing and re-closing on to a fault. The Swedish State Railways describe the method of operation in the following manner :—

« The line circuit breakers are re-closed automatically. If an earth occurs on the

contact line network, the feeding breaker in the substation is tripped by the action of a relay and an automatic re-closing device is, after that, automatically and immediately put into operation and functions in the following manner :—

a) The test breaker closes after a delay of five seconds and inserts a testing resistance in series between the 16 kV bus-bar of the substation and the line. The current is limited by the resistance (640 ohms) to a maximum value of about 25 A if the earth on the line remains. If there is no earth on the line, there is only a small amount of current fed into it, and the voltage attains practically 16 kV;

b) A potential transformer is connected to the line, and a relay controls the line voltage, when the test breaker is closed;

c) If there is no earth on the line, the relay, feeling the normal line voltage, activates the high-speed breaker, which closes, and the operation is restored;

d) If the earth remains during the testing operation, a voltage drop appears in the testing resistance, and the testing relay gets only an insignificant voltage. It cannot then activate the high-speed breaker;

e) After an additional lapse of 30 seconds, the testing breaker automatically recloses, and if there is no earth on the line, the high-speed breaker will also close afterwards;

f) If the earth remains, another re-closing operation is effected automatically after a lapse of a further three minutes. If also this trial has a negative result, the re-closing device is blocked, and an alarm is operated;

g) If an earth occurs on a line fed by two parallel operating substations, the feeder breakers in these stations open, and their re-closing devices are put into action almost simultaneously. When about two minutes have elapsed from the appearing of the fault, the interconnecting breaker on the line mid-way between the substations opens automatically, if the fault still remains. By the third re-closing operation of the breaker feeding the faultless section, the service on this part of the line is restored. The « dead » part has thus been limited to only half the original extent. »

Question 42. — *Are your line circuit breakers of the ultra-high-speed tripping type, or not? If they are, please indicate :—*

a) *What is the principle of operation of these breakers, and what is their approximate tripping time?*

b) *Whether you want to generalize this type of apparatus.*

c) *What is their price compared with that of normal-speed circuit breakers which you use or have used?*

Answers :

New Zealand Railways state that no ultra-high-speed circuit breakers are in use on their system and that latched-in type H.S.C.B's. are standard. The tripping time is stated to be 0.02 second.

The Central Section of the Indian Railways state that some slow-speed breakers are in use in sectioning cabins on their suburban line, but these are due for replacement by H.S.C.B's. which are standard equipment in main line substations.

All other Railway Administrations who replied to this question employ circuit breakers of the high-speed tripping type, solenoid-closed and magnetically-held, and whose operation depends upon the diversion of the magnetic flux in the holding armature, so permitting rapid release and avoiding all delays due to trigger movement. The tripping time is given as being between 0.01 and 0.03 second.

The Eastern Region of British Railways comment as follows on the principle of operation :—

« The moving contact is at the top end of the lever, the fulcrum of which is the holding magnet, pressure on the contacts being maintained by tension springs attached to the lever below the fulcrum point.

Series turns in the main load circuit neutralise the holding-on coil, thus releasing the fulcrum and allowing the tension springs to pull the lever back and separate the main contacts. The tripping time is 0.012 second. The magnetic holding field current is derived from the traction supply, and consequently varies with the voltage of that supply. This feature gives the C.B. a drooping voltage characteristic, which is considered to be of advantage under emergency supply conditions, as the effect is to reduce the normal overload current settings of the C.B. The overhead line is sectionalised by hand-operated line switches. »

The line C.B's. on the 16 kV, single-phase, 16 2/3-cycles system operated by the Swedish State Railways are oil-immersed with contraction chambers. They are spring tripped and electro-magnetically closed and their tripping time is stated to be approximately 1/2-cycle, i.e. 0.03 second.

Question 43. — *How do you protect :—*

a) *your feeders;*

b) *your contact lines*

against voltage surges and/or lightning? (Brief description and also schematic diagram. Indicate whether the protection against voltage surges is distinct from that against lightning).

Answer :

The provision of lightning arrestors is mainly dependent on whether the contact lines are supported overhead or at ground level. No Administration whose contact system is at ground level provides lightning or voltage surge protection. Also, only one Administration (New Zealand) out of those who operate an overhead system does not provide for lightning or surge protection, although this is stated to be under consideration.

In Great Britain, the general practice is to insert a capacitance (4 mF. approx.) with high resistance shunted across it and connected at the substation end of each section between line and earth. As an alternative, a recent modification to the above, employed by the Eastern Region of British Railways, is the use of the non-linear resistance type with spark gap, in which a resistance with magnetic blow-out coil across it is placed in series with the spark gap. No discrimination is made in either case between lightning and other voltage surges.

The Danish State Railways employ a similar type of lightning protection to the former type mentioned above and they comment as follows :—

« Each outgoing D.C. feeder is connected to a 4.4 mF. condenser placed on a bracket on the wall of the substation and mainly to protect the substation, but it will, of course, to some extent also protect the overhead line. »

In India, where electrical disturbances are likely to be frequent at certain times of the year, the overhead contact system of the Western Section of the Indian Railways is protected by horn gap arrestors at intervals of approximately one mile, and the substation by sealed type arrestors on either side of the substation.

The 1 500 V feeders of the Central Section of the Indian Railways are protected from lightning by electrolytic lightning arrestors in lightning arrestor cabins. The overhead contact line is protected by lightning arrestors provided on the structures.

All track feeders of the South African Railways are protected by lightning arrestors, but contact lines are protected only to a limited extent. No distinction is made between voltage surges and lightning.

Question 44. — *If you use, or have used, various types of protective apparatus against these incidents, which do you prefer, and why? (Local circumstances? Technical qualities? Financial motives?)*

Answer :

Preference for one scheme rather than another is not expressed in any of the replies.

Question 45. — *Are your feeders and contact lines protected agains other incidents of electrical nature? If so, which apparatus or devices are being used?*

Answer :

South African Railways comment as follows :—

« An overlap span is provided near each substation, in order to separate the contact line circuits between substations and provide the necessary protection through high-speed circuit breakers. A number of cases has occurred in the past when the overlap has been bridged by a train running from a healthy to a faulty section and, as a result, arcing has been started and maintained across the contact lines, thus causing the contact and catenary wires to break. In order to overcome the difficulty, protected overlap spans have been provided at all feeding points. The main feature is that the catenary wires between the tension bridges are insulated from each other, from the contact wires, and from the catenary wires on either side of the tension bridges. Each dropper is also insulated from the catenary and contact wire by means of two insulators, one at the top and one at the bottom. The object is to ensure that a vertical arc between one contact wire and the adjacent catenary cannot be established, as such arcing will be maintained until the overhead equipment is destroyed. Any arcing in a horizontal plane between adjacent contact wires cannot be maintained for a period long enough to cause damage and is extinguished by natural air convection currents and magnetic effects. More recently a section insulator with arcing horns has been developed to serve the same purpose. »

Section IV.

MOTOR VEHICLES.

Question 46. — *What are the fundamental characteristics of the main types of motor vehicles you have in use? Do not mention types intended to be discarded. More particularly, give for each type :—*

a) *Its denomination;*
b) *Number of vehicles;*
c) *Number of axles (2 axles or 2 trucks);*
d) *Rated tractive effort;*
e) *Highest speed on level track at full load;*
f) *Number and type of motors;*
g) *Voltage on terminals;*
h) *One-hour power rating;*
i) *Mode of acceleration (series-parallel or rheostatic only);*
j) *Any items specially installed for electrical or regenerative braking;*
k) *Capacity and rating of any such items.*

Answers :

The answers provided by the Railway Administrations to these questions are combined in a table accompanying this report.

Question 47. — *What apparatus do you use for the protection of these vehicles against overloads and/or short circuits? (Brief description and schematic diagram, if necessary, for comprehensibility). Please specify whether the protection against overloads is distinct from that against short-circuits.*

Answer :

There appears to be little variation in the methods adopted, and in general the arrangements consist of :—

a) Fuses for short-circuit protection;

b) Line switches, with overload relay or circuit-breakers, for overload protection, two line breakers in series being used in a number of cases.

On the Western Section of the Indian Railways, and on the Danish State Railways, pantograph fuses are provided, but short-circuit protection is regarded as being covered normally by the substation circuit breakers.

RAILWAY ADMINISTRATION	Type of motor vehicle	Denomination	Number of vehicles	Number of axles	Rated tractive effort
Association of American Railroads	Multiple Unit Cars	—	—	—	—
	Locomotives P.5a	2-C-2	—	3 driving	—
American Pennsylvania Railroad	Locomotives G.G.1	2-C+C-2	—	6 driving	—
British Railways : Southern Region	Multiple Unit Stock	— —	4 vehicles per unit	8 two-axle trucks, two of which have axle hung motors on either axle	1 800 lbs. co ous rating weakfield 2 450 lbs. at hour rating in field
Midland Region: Euston-Watford	Multiple Unit Stock	—	101	2 bogies 2 axles	18 520 ft. lb
Liverpool-Southport	Multiple Unit Stock	—	57	2 bogies 2 axles	16 400 ft. lb
Eastern Region: Liverpool St.-Shenfield	Multiple Unit Stock	—	92	2 bogies 2 axles	9 200 lbs. on field
Manchester-Sheffield	Multiple Unit Stock	—	8	4 axles 2 bogies	5 200 lbs. per continuous r 9 400 lbs. per on weak fiel
	Locomotive: Mixed Traffic Main Line passenger and freight	Bo+Bo	58	4 axles 2 bogies	8 700 lbs. pe continuous r 15 400 lbs. pe on weak fiel
	Locomotive: Fast Mixed Traffic	Co-Co	7	6 axles 2 bogies	17 300 lbs. pe continuous r 19 300 lbs. pe on weak fiel
Denmark State Railways	Multiple Unit Stock	—	102	2 trucks	5 500 lbs. at 50 m.p.h.
London Transport Executive	Multiple Unit Stock	O and P Stock	258 motor cars 99 trailers	2 motored bogies per motor car 2 bogies per trailer car.	2 930 lbs. pe tor at one I.E.C. rating
		R Stock	358 motor cars	2 bogies per motor car	2 900 lbs. pe tor at one I.E.C. rating
		1938/9 Tube Stock	920 motors cars	2 motored bogies per motor car	3 090 lbs. pe tor at one I.E.C. rating

hest eed evel ck full ad	Number and type of motors	Voltage on terminals	One hour power rating	Mode of acceleration series-parallel or rheostatic	Items specially installed for electrical or regenerative braking	Capacity and rating of any such items
.p.h.	2 A.C. 25 c/s 1.ph	850 V	200 H.P.	—	—	—
.p.h.	6 A.C. 25 c/s 1.ph	—	—	—	—	—
.p.h.	12 A.C. 25 c/s 1.ph	—	—	—	—	—
.p.h.	4 series wound, axle hung, nose suspended motors	660 V	250 H.P.	Series-parallel	—	—
m.p.h.	4. D.C. Series wound	580 V	320 H.P.	Series-parallel	—	—
m.p.h.	4. D.C. Series wound	580 V	235 H.P.	Series-parallel Bridge transition	—	—
.p.h.	4. D.C. Series wound	675 V	210 H.P.	Series-parallel	—	—
.p.h.	4. D.C. Series wound	750 V	210 H.P.	Automatic series-parallel with bridge transition	—	—
.p.h.	4. D.C. Series wound	750 V	467 H.P.	Hand controlled series-parallel with shunt transition	Exciter M-G set and stabilising resistances	25 kW continuous 35 kW hourly
.p.h.	6. D.C. Series wound	750 V	446 H.P.	Hand controlled S-S; P-P with shunt transition	Exciter M-G set and stabilising resistances	25 kW continuous 35 kW hourly
.p.h.	4. D.C. Series wound	800 V	163 H.P.	Series-parallel	—	—
n.p.h.	2. D.C. Series wound	575 V	152 H.P. at 600 V	Metadyne control	Metadyne regeneration	Continous temp. test taken at 560 V 224 amp.
.p.h. 53.5 % Field	2. D.C. Series wound	575 V	133 H.P. at 600 V	Series-parallel	—	—
.p.h. 70 % Field	2. D.C. Series wound	575 V	170 H.P.	Series-parallel	—	—

RAILWAY ADMINISTRATION	Type of motor vehicle	Denomination	Number of vehicles	Number of axles	Rated tractive effort
New Zealand Railways	Locomotive: Mixed Traffic	Bo-Bo-Bo	7	—	18 600 lbs. loco
	Motor Coach	Bo-Bo	14	—	5 200 lbs. per tor coach
South African Railways	Locomotives:				
	1E	Bo+Bo	172	4 axles	24 800 lbs.
	3E	Co+Co	28	6 axles	34 000 lbs.
	4E	1-Co+Co-1	40	8 axles	41 700 lbs.
	Shunting	Bo+Bo	22	4 axles	24 800 lbs.
	Motor Coaches	Bo—Bo	54	4 axles	12 000 lbs.
Swedish State Railways	Locomotives:				
	Da	—	—	3 driving 2 carrying	19 800 lbs.
	F	—	—	4 driving 2 carrying	21 350 lbs.
	M	—	—	6 driving 2 in trucks	35 200 lbs.
	Hg	—	—	4 driving 2 in trucks	19 350 lbs.
The Railway Board, India:					
Southern Section	Locomotives	—	4	2 driving axles	23 000 lbs.
	Multiple Units	—	24	2 axles motor bogies	—
Western Section	Multiple Units:				
	Old Stock	—	160	2 trucks per vehicle	25 000 lbs.
	New Stock	—	48	2 trucks per vehicle	34 000 lbs.
Central Section	Multiple Units		1 motorcoach 3 trailers	2 trucks per coach, 2 axles per truck	—
			2 motor coaches 2 trailers	2 trucks per coach, 2 axles per truck	—
	Locomotives	1-B-1	1	3 driving 4 bogies	—
		1-C-1	1	3 driving 4 bogies	—
		1-A-1	1	3 driving 1 pony & 2 bogies	—
		1-1-1	1	2 bogie trucks of 3 axles each	—
		1-G-1	1	2 motor trucks 3 axles each	—

ighest peed level rack t full load	Number and type of motors	Voltage on terminals	One hour power rating	Mode of acceleration series-parallel or rheostatic	Items specially installed for electrical or regenerative braking	Capacity and rating of any such items
m.p.h.	2. D.C. Series wound	750 V	1 800 H.P.	Series-Series Parallel-Parallel		
m.p.h.	5. D.C. Series wound	750 V	600 H.P.	Series-parallel	—	—
m.p.h.	4. D.C. Series	3 kV	374 H.P.	S.-P.	Exciter	28 kW
m.p.h.	6. D.C. Series	2 motors permanently	450 H.P.	S. S.-P. P.	—	—
m.p.h.	6. D.C. Series	in series	505 H.P.	S. S.-P. P.	Exciter	45 kW
m.p.h.	4. D.C. Series	4 in series	374 H.P.	Rheostatic	—	—
m.p.h.	4. D.C. Series	As for 1E, 3E	287 H.P.	S.-P.	—	—
m.p.h.	2 in series	500 V	2 500 H.P.	—	—	—
m.p.h.	4 in parallel	500 V	3 500 H.P.	—	—	—
m.p.h.	6 in parallel	430 V	3 600 H.P.	—	—	—
m.p.h.	2 in series 2 in parallel	335 V	1 760 H.P.	—	—	—
m.p.h.	2 in series 2 in parallel	750 V	165 H.P. each	Series-parallel	—	—
m.p.h.	2 in series 2 in parallel	750 V	120 H.P. each	Series-parallel	—	—
m.p.h.	2 in series 2 in parallel	675 V	1 100 H.P.	Rheostatic	—	—
m.p.h.	2 in series 4 in parallel	675 V	1 400 H.P.	Series-parallel	—	—
m.p.h.	4 per coach	750 V	275 H.P.	Series-parallel	—	—
m.p.h.	4 per coach	750 V	175 H.P.	Series-parallel	—	—
m.p.h.	6 per loco	750 V	375 H.P.	S. S.-P. and parallel	—	—
m.p.h.	6 per loco	750 V	370 H.P.	S. S.-P. and parallel		
m.p.h.	6 per loco	750 V	360 H.P.	S. S.-P. and parallel	—	—
m.p.h.	4 per loco	1 500 V	650 H.P.	S. S.-P. and parallel	Axle Exciter	37 volts 310 amps
m.p.h.	6 per loco	750 V	600 H.P.	S. S.-P. and parallel	Yes. Details	not known

On the Pennsylvania Railroad of America, a relay causes the pantograph to be lowered after the substation circuit breakers have cleared the fault.

The Swedish State Railways state that on the high-tension side there is an over-current relay for protection against short-circuits. Every motor is also protected against short-circuits and over-current at start by an over-current relay. These relays actuate the main breaker.

(Writer's Note. — Since all these so-called « overload » protective devices must be set to carry starting current, they cannot be regarded as giving protection against sustained loads whose value is in excess of the continuous rating of the plant. It would therefore appear that true overload protection is nowhere in use, and this is referred to again under « Conclusions ».)

Question 48. — *Are your motor vehicles protected individually against surge voltages and/or lightning? Please give brief description and schematic diagram, and state whether protection against « voltage surges » is distinct from that against « lightning ». Do the arrangements differ from those used on feeders and contact lines?*

Answer :

The protection of rolling stock against lightning and voltage surges is confined to those systems in which the contact line is supported overhead. The extent to which protection is provided depends mainly on the degree of security against lightning and voltage surges established on the overhead system and the susceptability of the area to electrical storms. Efficient lightning protection to the overhead system provides not only a first line of defence against damage to feeder cables, substations and rectifying plant, but also reduces, although not eliminates, the hazards of damage to rolling stock. The equipment provided for protection against lightning also serves as protection against voltage surges, and in no case is separate equipment installed to protect solely against either.

In Great Britain, where lightning storms are less frequent than in other parts of the world, the general practice is to rely mainly on the surge or lightning arrestors fitted to the overhead contact system at the substation ends of each section and to provide only limited protection to the rolling stock. This protection takes the form of either a choke coil in series with the pantograph or a specially reduced gap formed between the motor positive brush holder and to a boss cast on the inside of the motor frame.

In India, lightning arrestors of the horn gap type, with blow-out coil and series resistance, were originally fitted to the older type of multiple-unit cars, but these have failed on numerous occasions on the occurrence of lightning discharge, due to the sparking gaps being permanently bridged by molten metal and thus causing considerable interruption of service while the defective lightning arrestor was isolated from the power supply. On new multiple-unit cars, lightning arrestors of the electrolytic type by E.M.P., London, are being fitted and so far these have given trouble-free service.

In other parts of the world, variations of spark gap, choke coil and condensers are used with satisfactory results. In particular, reference is made to the South African Railways, where motor coaches are protected against lightning and voltage surges by electrolytic and capacitor type arrestors, together with a Ferranti surge absorber. This method has been found to be effective, but the maintenance costs of the former type are high.

On electric locomotives, the following protection equipment against lightning and voltage surges has been found to give trouble-free service :—

a) Two horn gaps in series on the roof;

b) A Ferranti surge absorber on the roof;

c) A spark gap with blow-out coil inside the locomotive.

Question 49. — *If you have used various types of protective apparatus against these incidents, which do you prefer, and why?*

Answer :

In reply to this question, India (Western Section) state that the sealed type of electrolytic arrestor is preferred by them, and London Transport make the following comments :—

« Voltage rises or surges are very pronounced on contact rail systems. These may be initiated by the clearing of a fault by the substation track circuit breaker opening whilst heavy current is flowing, or may be caused by the operation of very rapid types of circuit breaker on the trains.

The former type is of particular note on an all-insulated system such as London Transport, as a fault on one pole to earth will not cause any interruption to the supply, whilst a fault on the opposite pole, occurring at the same time but at some distance away, may allow high currents to build up without actually being sufficient to clear the protective setting on the circuit breakers, due to distance between the faults. When, however, the fault is cleared, a considerable voltage rise will occur, due to the collapse of the large magnetic field set up. Grounding of one pole and intermittent faults on the other pole will also cause the same form of voltage rise, but to a lesser degree, and the only satisfactory method of avoiding trouble is the sectionalisation of the D. C. tracks into small units, so that, firstly, the chance of simultaneous faults on each pole on the same section is reduced, and secondly, the resistance between the two faults is reduced, so that there is a possibility of the protective system operating.

With regard to the second cause, that of the operation of the train circuit breaker, this is of nuisance value to the equipment on the trains in the vicinity, especially where motor generators are used for the supply of lightning and auxiliary circuits, and with certain types of these machines it has been found necessary to include an inductance in series with the motor. Experiments have also been made with surge arrestors of the ceramic (non-linear) type, but these have not been generally adopted. »

Question 50. — *Are your vehicles protected against other incidents of an electrical nature? If so, which apparatus or devices are being used?*

Answer :

On the Western Section of the Indian Railways, no-volt protection is provided, which opens out the line breaker.

On the Swedish State Railways, vehicles with low tension regulation have — in the main transformer — the same winding for motor circuits and train heating circuit, and the bottom point of the transformer low tension winding has to be grounded. In the earthing point there is a current transformer feeding an overload relay, which actuates the main breaker when the current increases to 500 or 600 A. The relay acts as an overload relay for the train heating circuit, and as an earth fault relay for the motor circuit.

Vehicles with high-tension regulation have separate windings for motor circuits and train heating circuit. The motor circuit is earthed through a resistance, limiting the earth fault current to a maximum of 5 amperes, and in series with this resistance there is a current relay actuating the main breaker.

The train heating circuit has a current relay in the earthing point, as mentioned above.

On the Manchester/Sheffield Section of British Railways, motor coaches and locomotives are only protected against overload, but locomotives, in addition, have overvoltage relays to cut out regeneration if the pressure becomes excessive.

Section V.

REGENERATIVE BRAKING.

Questions 51 and 52. — *Is regenerative braking employed? If so, please give particulars of devices used :—*

a) *on the rolling stock;*

b) *in the substations.*

c) *Give particulars of the protective apparatus installed for these devices.*

Answers :

a) On the Manchester-Sheffield Line of British Railways, the locomotives are fitted with regenerative braking in addition to their normal braking requirements.

Regeneration on the locomotives is carried out by the traction motors, which are separately excited from a variable voltage exciter with stabilising resistances to compensate for changes in the line voltage.

The traction motor fields are supplied from the exciter in two parallel circuits. The armatures of the traction motor may be connected in series or parallel for Bo+Bo locomotives, and series or series-parallel for Co—Co locomotives, to increase the speed range over which braking is possible.

b) Absorption of regenerated current from the line at the substations is by means of loading resistances, which are connected across the line and running rails on a rise of potential above 1 750 V. Connection of the loading resistances to the line is rapidly affected by means of a thyratron triggered ignitron, which is, in turn, immediately shorted out of circuit by a contactor.

c) Protection of the locomotives during regeneration is provided by an over-voltage relay fitted with a slugged coil to permit the substation loading resistances to be connected across the line before the relay trips. This relay is set to operate at 1 950 V + or — 7 1/2 %.

The Bo+Bo locomotive has three overload relays, and the Co—Co four, one in each of the main motor circuits and one in the pantograph circuit.

Automatic air brake application to 25 lbs./sq. in. is applied if regeneration fails.

The exciter M.G. motor is protected by a 60 A cartridge fuse.

The substation regenerated current loading resistances are protected by thermostats to prevent overrunning. The control equipment for these loading resistances is fuse protected in the various auxiliary circuits employed.

The light load resistances provided on the traction supply rectifiers are designed to come into circuit at 1 650 V, thereby allowing a margin of 100 V, to prevent the rectifiers feeding into the regenerated current loading resistance, which comes into operation at 1 750 V.

a) On the Southern Section of the Indian Railways, electric freight locomotives are equipped with regenerative braking on account of heavy gradient sections. The excitations for the main motors, while regenerating, is supplied from two axle exciters.

One of the armatures of these generators is connected in series with each pair of motor fields and across the fields and exciter is connected a stabilising resistance, which completes a circuit for raising or lowering the current in the fields independent of the current flowing in the armatures, and this current, in passing through the fields, is always in the same direction for both motoring and regenerative braking.

b) For the rotary convertor unit to feed the D.C. reverse power, during regeneration back into the A.C. system, it must be capable of running inverted. The necessary re-arrangement of the compounding windings on the machine is controlled by the D.C. reverse power relay. When the reversal of current takes place, this D.C. reverse power relay operates and interrupts the circuit of auxiliary contactor for this relay, which, by opening in turn, completes the circuit of the series field short-circuiting contactor. This gives the unit correct compounding to work the rotary convertor inverted.

c) An over-voltage relay is connected in circuit ahead of the No. 1 motor, thus protecting the motors against over-voltage.

Overload protection is the same as that used during motoring.

a) On the South African Railways, motor groups are connected in series or parallel and the fields of the traction motors are excited separately, the excitation current being adjusted by adjusting the exciter generator field.

b) In each substation where regenerative braking is employed, two rectifier units are installed. One is operated as an invertor, which converts the regenerated D.C. current to A.C. at high-tension for transmission to other parts of the system where a demand for energy exists.

c) Each invertor is provided with a unit high-speed C.B. and a current-balance relay, which is arranged to shut down the invertor in the event of the D.C. current at the positive and negative terminals not being equal (i.e. balanced), such as would occur if flash-over on the invertor occurred.

a) On London Transport, regenerative braking is provided on 258 motor-cars, and on each of these a group of four motors, operating in two groups of two in parallel, are supplied from a single Metadyne equipment.

No special equipment is provided in the substations, as there is usually sufficient load provided by other trains in the section to absorb the energy produced by regeneration. Should such a load not be available, a loading resistance provided on each motor-car is used to absorb the regenerated energy, the resistance being cut-in automatically by means of a high-speed relay operated by the rise of voltage. In addition, the regenerative braking notches on the controller are combined with the electro-pneumatic brake and are operated by the same handle. There are two regenerative braking notches, the first giving a low rate of de-acceleration by means of the Metadyne and by a light application of the air brakes to all non-motored axles. The second notch gives the maximum regeneration possible and increases the pressure to the air brakes. Further notches give normal electro-pneumatic braking on all axles and emergency braking without regeneration. Thus normal air-braking is always available, if required, by a further movement of the controller, and this can be regarded as a standby or emergency brake.

b) As stated above, no special equipment is provided in the substations and the supply system is not arranged to accept regenerated current. All rotary convertors are fitted with reverse current D.C. breakers and these open automatically if the amount of regenerated current exceeds the load provided by other trains in the section. Where the supply is provided by rectifiers, reversal of direction is prevented by the properties of the rectifier.

c) Each Metadyne equipment is protected with relays against overload and over-voltage. The Metadyne primary circuit is protected against overload and over-voltage by relays which are designed to trip the main circuit breaker while the secondary circuit (which includes two pairs of D.C. series motors) is protected by plain overload relays, each arranged to trip the line switch which controls the pair of motors affected. Overload relays are also provided in the regulating dynamo circuit, and these are arranged to trip the main circuit breaker should the current exceed a predetermined value.

SUMMARY.

After reviewing the answers which have been summarised in the foregoing report, it is the Writer's opinion that the following conclusions can be drawn :

Overload protection.

All the appliances used to secure protection against « OVERLOAD » are, in reality, only suitable for protection against fault. Consider, for example, a rectifying equipment which conforms to B.S.S. 1698 1950, Class III (Railway Service), for which the following performance is required

100 per cent. rated current continuously;

150 per cent. rated current for two hours (*);

300 per cent. rated current for one minute (*).

In order to protect such a plant from overload, a device is required such that 300 % load may be carried for one minute but will be interrupted if it tends to be maintained for longer than that period. Similarly, 150 % load must be permitted for two hours but must be interrupted if this duration tends to be exceeded, and since only 100 % can be carried continuously, the device must operate if 101 % tends to be demanded for longer than, say, four hours.

The problem is still further complicated, since a definite interval must be insisted upon between successive periods of overload, and although no stipulations are made in B.S.S. 1698, it would appear reasonable to assume that a period of reduced load (less than 100 % continuous rating) must follow each period of overload and be of such value and duration that an amount of cooling is produced equal to the amount of excess heating which took place during the preceding overload. A completely logical overload device for such an equipment would, therefore, require to have an inverse-time characteristic such that the time of operation would vary with load between the values of four hours and one minute, and in addition, would need to take cognizance of the reduction in load necessary between overloads and suitably to reduce the permissible duration of any subsequent overload which might occur before the required degree of cooling had been effected.

No such relay is at present in use and it is felt that all systems of so-called overload protection fail to meet the specific requirements of the plant with which they are associated.

Induction pattern A.C. relays, having an inverse-time characteristic, are of course available and, as shown in the above summary, they are used extensively for the protection of rectifier transformers and high-tension cables, but although they are fitted with adjustable time and current settings, the values obtainable bear no relation to the actual times for which the currents may safely be carried by the plant they are intended to protect.

Differential systems of protection are also essentially unsuitable for « OVERLOAD » protection, since, as their name implies, they depend not upon the actual value of the current traversing the protected circuit but upon the difference between the quantity entering and the quantity leaving the circuit. In consequence, any such system cannot be regarded as protection against overload and, in fact, one of the desirable qualities of such a system is that it shall remain inoperative even if the through-current reaches a value several times greater than the rated capacity of the protected plant, and much ingenuity has been expended in an effort to secure the requisite degree of stability under the various operating conditions that obtain in practice.

The example considered above refers to a single class of rectifying equipment, but similar considerations apply to all other classes and also to traction motors which have both a continuous and a short-time rating, and they also apply to some extent to cables.

The current rating assigned to any type and size of cable is that which it can carry continuously without exceeding a prescribed temperature rise, but if switched on at ambient temperature, this load can be carried for a number of hours (up to 15 in the case of some buried cables) before the final temperature is produced. In consequence, if the cable is at a lower temperature than that permissible for continuous operation, considerably higher values can be carried for short periods.

On suburban railways, where intensive services are run for about two hours during each morning and evening, and are then

(*) Each after three hours at rated current, starting from ambient temperature.

followed by periods of reduced load, and by an almost complete cessation of load for some hours during the night, this feature permits cables to be operated during periods of peak demand with current densities considerably above those permissible for continuous operation, and it is extremely valuable in the case of track feeder supplies to a 600 V D.C. railway, where starting currents of 4 000 A are frequently demanded for periods of only 10 to 15 seconds. Such loads can safely be carried on 169/.103 cables (one at each end of the track section) but it will be apparent that any circuit breaker set to carry these high currents cannot be regarded as giving adequate protection against overload, since a very much smaller current sustained for any lengthy period would represent a considerable degree of overload and would readily damage or destroy the cable.

There is thus an immediate necessity for an improved type of overload protective device, and in view of the difficulties in applying integrated values of i^2t, an alternative approach may prove desirable.

Some progress has been made in the production of fuses in which the time of operation is related to the magnitude of current, but this relationship does not yet agree satisfactorily with the requirements at all values of load. Furthermore, since each fuse requires to be renewed after operation, they can become very expensive, and as the plant is out of service (or only part of the capacity remains available) until the damaged fuse has been replaced, they introduce delays which render them unsuitable for use in unattended substations.

Fuses in the anodes of rectifiers also introduce difficulties in the event of short-circuits on the D.C. system beyond the D.C. bus-bars, since they may frequently be blown before the track circuit breaker has had time to operate.

Further types of devices intended to give overload protection are also in common use in the form of thermal relays, or contact-making thermometers, and since both types depend for their operation upon a temperature-sensitive device, they appear at first sight to offer a simple means of affording the required degree of protection.

Except in certain special types of plant (rectifier bulbs, etc.), the main factor in deciding whether the equipment is being endangered by overloading is the temperature of the working parts, and so long as the hottest point is at a temperature below that which will cause damage or unduly rapid deterioration, there appears to be no reason for regarding it as overloaded or to require any interruption in its operation. If then a temperature-sensitive device could be relied upon to indicate the hottest point of the equipment, contacts could readily be provided so that operation of the plant would be interrupted only when the safe temperature tended to be exceeded, and all current values and time durations could then be ignored.

There are, however, obvious difficulties even with this arrangement, since the position of all the hot spots would have to be accurately known in order that the temperature-sensitive device could be located properly. In an oil-filled transformer, the temperature of the oil might readily be several degrees less than that of a hot spot produced for only a few seconds by an abnormally high current, and since such a hot spot could readily damage the adjacent insulation without appreciably affecting the temperature of the large body of oil, its precise location would be of paramount importance.

In many cases it might prove impracticable to locate the bulb in the required position, and difficulties would obviously arise in regard to insulation and accessibility for testing purposes, whilst in the case of rotating machinery, still further difficulties will be apparent.

In the case of thermal relays, where the temperature-sensitive device is heated by an element carrying current proportional to that carried by the protected plant, there can be no guarantee that the thermal storage capacity and heat dissipating qualities of the device will coincide with that of the

hot spot, and in consequence relays of this type cannot be regarded as suitable for the protection of expensive plant.

In view of the shortcomings of the existing devices and of the difficulties shown to exist in the development of alternative types, it is felt that the position regarding overload protection is at present generally unsatisfactory.

Short circuit protection.

It is usually imperative to disconnect any short-cuircuit in the shortest possible time, and on terminal feeds the instantaneous relays and the high-speed circuit breakers with impulse tripping, as commonly employed, appear to be satisfactory. Where two or more pieces of apparatus are electrically in series, however, it is desirable to disconnect only those portions of the circuit which are rendered inoperative by the fault, so that operation of those portions nearer to the source of supply may not be interrupted.

Over-current relays with graded time and current settings (which lengthen as the short-circuit value increases) permit this to be achieved to some extent, but they obviously introduce a time delay during which considerable damage may be done, and they cannot therefore be regarded as completely effective for short-circuit conditions.

In the case of a rectifying equiment supplying a number of sections of the track, a short-circuit on any one of the tracks should be cut-off by the D.C. circuit breaker and the remaining tracks and the rectifier should remain unaffected. However, if instantaneous A.C. relays be provided on the latter for protection against back-fire, then any short-circuit current causing the opening of the D.C. breaker may also initiate the operation of the A.C. relay, so that the rectifier will be shut down as a result and the supply to the healthy tracks will also be affected, whilst, in addition, a heavy stress will be imposed upon the A.C. breaker.

These undesirable features can be avoided by slowing down the operation of the A.C. relay, but by so doing the essential speed of operation required under back-fire conditions has to be sacrificed and this solution cannot be regarded as satisfactory.

In view of these difficulties, arc-suppression would appear to be the most suitable protection for rectifying equipment against both short-circuit and back-fire conditions, since its action is the most rapid available, avoids operation of the A.C. breaker, and permits immediate re-start, so that should its operation be brought about by a straight-through fault, intended to be cleared by the D.C. breaker, no serious interruption will take place on the feeds to healthy circuits.

H.T. bus-bar protection.

The provision of appliances to safeguard high-tension bus-bars in railway substations appears to be comparatively rare, yet it must be accepted that the danger of breakdown is always present, and unless the fault can be cleared in the shortest possible time, considerable damage may result and all circuits fed from the bars will be out of service until repairs have been effected or until emergency connections have been provided.

Should the equipment include outgoing feeders giving supplies to substations, further along the line, these also will be affected and the train service may be interrupted over lengthy sections of the line.

Where the high-tension cables feeding the bus-bars are equipped at their supply end with overload and earth leakage relays, some measure of protection is afforded, since a fault on the bars at the receiving end will cause these to operate and will thus be cleared from the supply end.

On the other hand, should the incoming feeders be equipped with only differential protection, these will have no tendency to operate and the fault will not be disconnected until it has burnt itself clear. In such cases it is therefore essential to provide either some form of bus-bar protection at each substation or to augment any differ-

ential system of feeder protection by means of overload and earth leakage relays.

For railway purposes the substations are necessarily located at intervals along the track, and the obvious method of providing a high-tension supply is by means of a feeder from the source of supply into the nearest substation, and then out again to the next substation ,each section of cable between substations being provided with a circuit breaker at each end, so that it may be disconnected automatically in the event of its becoming faulty. Where only one source of supply exists, duplicate feeders are necessary to safeguard against interruption to all substations beyond any fault that may occur, but where additional sources of supply are available at points along the route, a single feeder is frequently regarded as sufficient, since it can then be fed at both ends and any single section between substations can be put out of service without interrupting the supply. It is in these cases that differential systems of protection are usually installed, but it must be borne in mind that, unless supported by over-current and earth leakage relays, they give no protection against faults on the bus-bars in any of the substations, and even if so supported, such a fault would result in shutting down all substations between the locations of the back-up protection.

In view of the widespread interference in the operation of the train services which would result from such a stoppage, it would appear that back-up protection is only a partial solution, and that an effective system of bus-bar protection should be installed at all substations.

REGENERATION.

The additional apparatus required for the purposes of regeneration does not appear to introduce any insurmountable difficulties with regard to protective devices either on the rolling stock or in the substations, and the main problem (apart from ensuring that a reliable and effective means of braking will be available under all conditions) is to ensure that a suitable load will exist whenever regeneration is required, and to prevent any undue rise of voltage should such a load fail to be available.

In view of the speed with which the regenerated voltage may increase if this first requirement is not fulfilled, it is essential thay any devices for bringing alternative loads (or alternate systems of braking) into operation must operate with extreme rapidity, and those at present in use on the Metadyne stock of London Transport have not been completely satisfactory in this respect.

It would appear that only electronic devices are likely to meet these requirements completely, but owing to their comparatively fragile nature, it is doubtful whether these would be able to withstand the operating conditions on the trains. They are, however, being used within the substations on the Manchester-Sheffield Lines of British Railways, and it is understood that, so far, they have given satisfactory service. In the Writer's opinion, however, considerably longer experience is necessary before the arrangements can be accepted as completely satisfactory.

LIGHTNING AND VOLTAGE SURGE PROTECTION.

Where apparatus is installed as a protection against lightning, the same apparatus is considered sufficient to protect against voltage surges, and no cases have been reported where apparatus is provided to protect separately against each type of fault.

In view of the comments made by the users of horn gaps, it would appear that these are not completely satisfactory, and the general tendency seems to be towards the adoption of the electrolytic type of surge arrestor.

Having carefully considered the answers supplied by the various Administrations, it appears that a number of special problems arise in connection with the protection of electrical equipment required for railway operation, and the solution of these will have to be found by Railway Engineers.

The problems arise chiefly from the heavy starting currents required, since these frequently exceed the continuous rating of the plant, and they affect not only the high-tension feeders supplying the substation but also the converting plant, track, feeders, contact-system and rolling-stock.

On the other hand, the methods of protection required in the earlier stages of the supply — from the generators to the railway distribution centre — are common to all electrical systems, and the commercial relays used throughout the supply industry can generally be used satisfactorily.

[656 .257]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

16th SESSION (LONDON, 1954),

QUESTION 6.

a) Remote operation of signal boxes: technical realizations, working orders.

b) Electric working and control devices for hinged and « flexible » points and switches.

Control of accidental trailing of the switch blade.

REPORT

(Austria, Bulgaria, Czechoslovakia, Germany, Hungary, Poland, Rumania and Yugoslavia),

by Prof. A. Dobmaier, (*)
Direktor der Hauptverwaltung der Deutschen Bundesbahn.

The questionnaire was established in collaboration with the German Federal Railways and distributed by the Secretary of the International Railway Congress Association to the Administrations of Austria, Bulgaria, Hungary, Poland, Rumania, Czechoslovakia and Yugoslavia with a request for a reply. Only Austria has answered the questionnaire. The other countries have not even given an explanation why they did not submit any information. This has strongly influenced the evaluation of the answers and very much complicated the reporter's task. As it is, a comparison between the Austrian and German answers only is possible.

As far as the answers to question 6 a) (remote control of signalboxes) are concerned, it can readily be assumed that all Administrations who have not answered the questions, either have no such installations or, if so, have only experience with such of minor importance installed on secondary lines.

With regard to question 6 b) (electric point machines), the Secretary has had to report with regret that 6 countries have not replied, since this has a detrimental effect on the value of the recommendations to be published by the Association.

A. — **Answers to question 6 a) : Remote control of signalboxes; structural design; operating rules.**

Contrary to the German Federal Railways, where remote control installations

(*) Owing to new functions assigned to Prof. A. Dobmaier, the duties of Reporter at the London Congress will be entrusted to Mr. Grünewald, Dr. Ing., Deutsche Bundesbahn, München.

already exist and are installed in individual signalboxes located within station areas, and on complete lines of lengths up to 100 km, the Austrian Federal Railways have installed such only in some isolated cases at station signalboxes. Both, the German Federal Railways and the Austrian Federal Railways intend to establish such systems at junctions and stations with passing sidings. Owing to this, all answers referring to the remote interlocking of stations and local layouts (all locations where switches, signals, etc., are operated and detected by special apparatus) on complete lines concern only the German Railways. The answers of the Austrian Federal Railways to all other questions concerning the remote control of signalboxes need to be considered from this restricted point of view.

The remote control of switches and signals of individual station signalboxes is chiefly a technical question and not a function of the operating methods, as it is in the case of the remote control of stations along a line, etc. In the latter case, the mode of operation has a strong influence on the design of the remote control system. It is necessary to bear this in mind if the installations of different countries are to be compared. Since the operating rules of the Austrian Federal Railways are similar to those of the German Federal Railways and since a comparison would be of special interest in this case, it is all the more regrettable that the Austrian Federal Railways have no experiences with the remote control of stations along an entire line (C.T.C.).

In what follows the abbreviation Ö.B.B. stands for Austrian Federal Railways and D.B. for German Federal Railways.

In Austria, saving of operating staff and the reduction of expensive cable laying were the decisive factors in the introduction of remote control interlocking at individual operating points. The German requirements for such installations are more extensive; apart from the aforementioned important reasons, the D.B. hopes to increase materially the track capacity. In addition, centralization of operating and safe control of train movements are reasons in favour of the installation of such systems. Only the use of remote control interlocking permits on double track, with suitably located crossovers, of diverting one train or another — if arranged to run at different speeds — so that a fast train can be run around a slower, and all trains be kept moving at normal maximum speed. Moreover, it is hoped to defer the installation of a second track in numerous instances either partly or completely. So far, C.T.C. has only been applied on double-track; however, this came about by mere accident, since it would have been possible also to select single track territory. Generally, heavy traffic lines with a great number of small stations and only a limited number of large stations, i.e. stations which have to be permanently occupied by operating staff and where numerous shunting movements have to be carried out, are preferred. The term large stations involves all stations to which *one* shunting locomotive has been permanently assigned. Thus, the number of tracks and trains is only of secondary importance in considering whether a station can be remotely controlled or not.

In Germany, central control machines from which the signals and switches at stations over an extended territory are controlled are in service at Nuremberg for the double track line Regensburg-Nuremberg and at Cornberg for the double track line Bebra-Cornberg, with train movements on both tracks in either direction.

The Regensburg-Nuremberg line is 83 km long; its total capacity amounts to 150 trains per day in both directions. This line comprises the following operating points: 3 major stations (for which special control circuits are required), 6 remotely controlled (smaller) stations, 3 stations with key interlocking, 4 halts with protecting signals, 1 passing siding, 1 two-sided block post and 1 one-sided block post. The most important remotely controlled station

comprises 14 switches and 6 signals; the overall number of all remotely controlled switches amounts to 74 and that of all signals to 90. The distance of all remotely controlled local posts from the central interlocking plant varies between 14 and 82 km. This line cannot be utilized for train movements in the same direction on both tracks.

The part of the 12 km long Bebra-Cornberg line provided with remote control interlocking is 7 km long; its capacity is 170 trains per day in both directions. Incorporated in it are two crossovers and 30 distant and stop signals, the control elements of which are concentrated in one post remotely controlled from the 12 km distant central control machine. The section has a gradient of 13 $^{0}/_{00}$. Train movements in both directions are possible on the down track, provided with 4 crossovers.

There are no lines with remote control interlocking in Austria, but only some isolated, remotely controlled local installations are under construction, not more than 1 km distant from the central control machine.

The remote control interlocking comprises all switches and signals and in one case even two level crossings gates on a secondary line with small traffic.

Remote control interlocking for stations with several passing sidings is not yet available (neither in Germany nor in Austria). In such cases, the D.B. contemplates subdivising the station area into several remotely controlled zones. The application of remote control interlocking for junctions outside major stations, or for signals located at a great distance from such stations, in order to centralize the control of the signals at one point, is envisaged in Germany and Austria, but such installations are not yet in service.

Since there are no such C.T.C. lines in Austria, the question concerning block working between two remotely controlled stations can only be answered as far as the block sections adjacent to remotely controlled signalboxes are concerned.

The Ö.B.B. employ the relay block, in which part of the working is accomplished automatically and part over the remote control system. Indicators in the signalbox show the occupation of the adjacent block sections.

Up to now, the C.T.C. lines of the D.B. have been provided only with automatic signalling. The occupation and clearing of the sections located between two remotely controlled stations is signalled to the central control machine. As a rule, approach zones are not specially signalled. The approach zone commences at least 300 m in rear of the outer distant signal and extends to the home signal itself. As soon as a train enters this zone, the local operator is no longer in position to return the stop signal to danger by means of the normal signal lever; otherwise it would be impossible to indicate, in time, to the driver at the distant signal that the signal aspect was changed. In emergency the signals can be put to danger by using a so-called auxiliary signal lever.

All automatic signals display an absolute stop aspect; the stop and clear aspects are repeated at the central control machine. Outgoing controls, to and incoming indications from the *automatic signals* are first transmitted to the next apparatus location (next station) and from there to the central control machine.

All signals operated by the dispatchers at C.T.C. signalboxes on the D.B. are provided with permissive subsidiary signals. Moreover, the signals have speed indicator signs (speed restriction and speed acceleration signs) which are operated from the central apparatus, in order to increase the track capacity.

All switches at stations on a C.T.C. line are exclusively electrically controlled and repeated. The Ö.B.B. employ the same system for the controlling and detection of switches.

The efficiency of the Austrian and German remote control systems differs essentially. Under the assumption that transmissions are confined to *one* direction only,

the Austrian system permits only the connection of some 5 local layouts with 6 to 8 sets of field apparatus. On the contrary, the German system has been so designed that any number of such layouts can be connected, and if a great number has to be connected to the system, it is recommended to locate the central signalbox half way along the line, so that transmission can be made in both directions and thus reduce the time the transmission channels are occupied. The poor efficiency of the Austrian system is probably due to the fact — mentioned already — that, for the time being, the application of remote interlocking is limited to signalboxes at individual stations and junctions only, and that remote interlocking of all switches and signals on a line was not envisaged.

The German system permits of covering distances up to 200 km. Without using any carrier equipment the Ö.B.B. cover distances up to approximately 60 km. At the present moment it is not contemplated in Germany, to exceed distances of 100 to 120 km (depending on the density of the traffic), in view of the fact that the dispatcher can only deal with a certain amount of mental work.

Austria uses for the transmission of outgoing controls and incoming indications direct current, while Germany applies inductive selection. The introduction of transmission systems using A.C. and D.C. is contemplated in Germany.

The Austrian code system uses relay chains and time codes (length of code). The transmission line is permanently energized. The receiving relays are connected in series.

The D.B. also introduced a code system with relay chains for the selection of the local layouts; however, rotary selectors serve for the transmissions between the central signalbox and stations. According to the number of stations to be selected, the code consists of 2, 4, or 6 code pairs.

Contrary to the Austrian system, the D.B. uses polar code. The selection relays are connected in parallel. In both countries the insulation and continuity of the transmission line is not permanently detected. However, the D.B. contemplates the introduction of a permanent detection, to prove everything is in order.

Neither in Austria nor in Germany are there remote interlocking systems where a separate carrier frequency has been assigned to each individual local layout, or each piece of apparatus. Both countries agree that the most suitable thing is to effect the interlocking between signals and switches at the local layout. While it is feasible in Austria remotely to control switches individually, as well as when setting up a route, the D.B. applies a system, where the respective switches for a train movement are positioned simultaneously with its being set up, and at the same time this occurs, only the closed position of an operated switch or its failure to close (in the case of any thing being wrong) is indicated. As far as shunting movements are concerned in Germany, the switches are not controlled from the central control machine, but in all cases from a local control panel or apparatus case, after the electrical release of the switch has been received. At minor stations the operating panel consists only of an operating box which incorporates the control apparatus for the entire post, while, in Austria, the local operation of switches is envisaged in some rare cases only.

Austria uses, for operating switches and signals, jack switches or buttons; the D.B. employs exclusively buttons. In Germany, these are always arranged in geographical position on the track diagram while the Ö.B.B. uses this arrangement in the majority of cases. Coloured lamps are used in both countries for indication purposes. The Ö.B.B. central signalbox has indicators which show the normal and reversed positions as well as any disturbance of a switch. On the German C.T.C. line, Regensburg-Nuremberg, only the closed position and any disturbance of the switch points is shown; on the Bebra-Cornberg line the normal and reversed positions of the

switches also are indicated. In both cases, the trailing through of a switch is regarded as an unusual occurrence.

A two-core cable (copper) with a diameter of 1 mm each, or open wire lines (uninsulated iron wires) with a diameter of 3 mm, serves in Austria for the transmission of outgoing controls and incoming indications. To protect the transmission lines against high voltages or atmospheric influences they have been provided with cathode type lightning arresters functioning at different voltages. For the time being, the D.B. uses cables only (tests with open wire lines have been started), and 2 or 4 conductors with a diameter of 0.9 or 1.4 mm constitute one remote control transmission channel. On light traffic lines two such conductors constitute one channel, and on heavy traffic lines 4 conductors serve for the creation of one channel with a phantom circuit. If inductive selection has been introduced these circuits can be pupinised or not; if A.C. telegraphy is employed it is absolutely necessary to pupinise the circuits. In both countries, the circuits are *successively* used for the transmission of outgoing controls and incoming indications.

Tests carried out in Austria on a 20 km long line have shown that, on A.C. electrified line, it is only necessary to take special measures — in connection with a D.C. operated transmission system — to protect it against induced currents if underground cables are used. The Ö.B.B. have given no hints as to the method applied to protect these circuits against these currents. The D.B. avoids such disturbing effects by the application of special protection measures with regard to the cables and by using inductive impulses.

The number of transmission channels depends in each individual case on the number of remotely controlled locations and on the traffic on the line during peak hours. In view of the transmission distances from 1 to 2 km — one channel is sufficient to satisfy the requirements of the Austrian system.

While the remote interlocking system of the Ö.B.B. cannot be extended to transmit any desired number of outgoing controls or incoming indications on account of the required long transmission times, the German system has been so designed that any desired extension can be accomplished by the provision of additional transmission channels, by using A.C. transmission, or by the subdivision of a C.T.C. line into several sub-zones. The time required for the actual transmission of outgoing controls and incoming indications is 2 to 6 sec. in Austria against 2 to 4 sec. in Germany. In both countries, the outgoing control impulses are stored by means of relays; however, there is one difference, in that these impulses are automatically transmitted as soon as the channel has been released (in Germany), whereas, in Austria, the actuation of a special transmitting key is required. The German system provides for the successive reception of all incoming indications without giving preference to others; this is accomplished by means of synchronised rotary selectors; in Austria the incoming indications are in groups, and special preference is given to certain of them.

Austria and Germany employ telephone relays with polarized and neutral armatures. The neutral relays of the Ö.B.B. have a maximum of 6 contacts and a core of 22 sq. mm section. The space provided for the coil is 350 sq. mm. All individual relays have brazed contacts; there are no screwed contacts. Only the German relay groups have been provided with plug-in contacts (knife-edged contacts).

In view of the limited amount of remotely controlled apparatus in Austria the transmission speed of a D.C. system is sufficient to satisfy all requirements. On heavy traffic lines with a great number of stations, outgoing controls and incoming indications, the D.B. employs inductive selection.

The use of points with direct locking is customary in Germany and Austria. The key for this purpose is released by the dis-

patcher via a remotely controlled electric key lock. Indirect locking is only provided at points which are taken by trains moving in *one* direction.

In both countries remotely controlled apparatus is fed from local current sources, i.e. relays are supplied with D.C. from batteries and the signals with A.C. from the local network of a supply company. The D.B. uses 380 V three-phase current for the operation of points and 220 V, 50 cycles, for the track relays installed on steam operated lines and 220 V, 100 cycles, for track relays installed on electrified lines (traction current 16 2/3 cycles). In Austria all points are connected to batteries, or to a local supply.

All signals in Austria are provided with an emergency current distribution circuit as are also all points connected to a public supply. All German installations have been provided with an auxiliary source of power.

Electric heating devices for points are not met with, in either country. Tests with them and with propane gas burners are being carried out by the D.B.

The requirements of the D.B. in respect of the indication of failures are stricter than those of the Ö.B.B. The D.B. requires the following occurrences to be indicated: interruption of the transmission line, failure of points, failure of a signal lamp, failure of the relays at the outlying locations, and interruption of the power supply. The Ö.B.B. consider it unnecessary to indicate a failure of the transmission line or of relay groups.

In both systems a failure at a remotely controlled location does not affect others but a failure of a transmission line must, of necessity, always affect them, if only one transmission channel is available.

The importance which the D.B. attaches to using remote control on heavy traffic lines makes it absolutely necessary that, even in case of any failure developing, traffic operations must continue to work smoothly, without difficulties.

The Austrian practice, where in case of any failure signals cannot be controlled and all points must be manually operated, is unsuitable for introduction in Germany. For this purpose the D.B. has equipped each remotely controlled location with a control panel and the necessary apparatus for the entire location which can be used if any failure occurs, or if the remote control is put out of action. Thus, even in case of a failure or disconnection of the remote control system, all signals of the main through tracks — set by the dispatcher for through operation — remain functioning to control train operation. The changing-over to remote control is made in accordance with the direction of traffic; and the changing-over to local operation can be made only for the entire station area. As far as the stations with key interlocking are concerned, it is necessary, before the sealed key can be used, to obtain the dispatcher's authorisation by telephone.

In Austria, it is the guard who receives authorisation by telephone to pass a failed signal. In Germany, this authorisation is given by the aspect displayed by an emergency signal, and only if this fails is the authorisation obtained by telephone, to avoid trains getting off their schedule. In Austria, failed points are operated only in exceptional cases by the guard. In Germany, they are operated by a member of the traffic staff by means of a crank and secured by a point lock.

If a change of a route is required, or if a failure occurs, the route is released, in both countries, by means of an emergency release button located in the central signal-box. The time required for the complete release of the route, following the putting of the signal to danger, depends on trains speed and length. On heavy traffic lines the D.B. has envisaged sectional route release, in order to reduce the time required. Time relays are only installed in connection with remote control for the release of overlap sections; with local operation in force a special cancelling key must be operated, after it has been ascertained that the train has stopped normally at the prescribed location.

Should a cable fail, i.e. outgoing control impulses be no longer transmitted and incoming indication impulses be no longer received, the German requirement to equip each location with complete control facilities, offers great advantages from an operating standpoint. In such an event, the dispatcher tries to reach the respective station by a direct telephone line or over non-railway-owned telephone circuits, and orders local operation and the signalling or, if required, the telegraphic reporting of the passing of trains. With the Austrian system, the protection of a train entering a station takes much more time, owing to the absence of any local control panels; however, the Austrian method is sufficient to meet all requirements.

Graphs recording traffic operations are only used in Germany; this is accomplished by means of automatic train movement recorders. The graph paper — with the schedules printed on it — moves at a speed of 60 m.p.h. The occupation of each section and the time required for it is recorded by means of a row of pens, arranged in accordance with their geographical situation. The recording pens are actuated via the indication relays of the block sections. One pen has been assigned to each block section and one train movement recorder has been provided for each direction of traffic.

In Austria, it is the dispatcher of the central control machine who is responsible for the safety of passengers who have to cross one track of a double tracked line in order to board or leave a train. This solution cannot be applied where the remote control involves a great number of stations located on a long line. In Germany, it is the local operating official who is responsible for the safety of the passengers. As soon as a so-called P-sign (passenger train required to stop at such a location) appears to announce a train arriving on the track most distant from the station building, the local official has to set the home signal for the opposite direction at danger or, if the approach zone has already been occupied by a train arriving from the opposite direction, he has to put the home signal for this train to danger. If the official fails to carry this out, the signal for the passenger train goes automatically to danger after a certain time has elapsed.

The indication of the train numbers and type of train by visual means is customary only in Germany. Their transmission is coupled with the indication of the block section occupation, and they are shown at all remotely controlled and major stations, while at stations with key interlocking, at halts, and at level crossing gate posts only the type of train is shown.

In Austria, there are telephone circuits between the central signalbox and the remotely controlled location (to exchange messages concerning shunting movements and the setting and locking of switches in case of failures) and the home and starting signals. The D.B. considers the following telephone facilities essential: one circuit between the central signalbox and all locations where relays have been installed (the local operating official must also be connected to this circuit, with the point operating shelter, and the point key hut); one special telephone circuit between the central signalbox and the signals (one for each direction of running). The maintenance staff is required to use the special telephone circuit provided for them at the locations where relays have been housed.

The German C.T.C. line Regensburg-Nuremberg (total length 83 km), has been subdivided into 4 maintenance districts. Headquarters of district No. 1 are located at the central control machine in Nuremberg and the headquarters of the other districts are located at three major stations distributed along the line. Motor vehicles are available for these men. One man has been permanently assigned to each district for fault finding and preventing purposes (working in three shifts), and only minor maintenance jobs are carried out. So far no experience has been obtained with regard to the employment of maintenance workers for systematic

reconditioning of the remote control apparatus.

Operating rules.

Special operating rules have been laid down for the C.T.C. line Regensburg-Nuremberg. Chapter A contains the additional regulations in respect of the operating rules and chapter B deals with complementary instructions concerning the German signal code. Both chapters contain all new regulations, not mentioned in the operating rules or in the signal code.

B. — Answers to question 6 b) : Electric point machines and detecting devices for articulated switches and switches with spring points. Control apparatuses for switches being accidentally trailed.

Switches (or points).

The provision of point locks at all switches used by running movements is considered absolutely necessary in Austria and Germany in order to obtain safe locking of the point tongue. Moreover, if it is required that points shall be trailable, using a point lock permits the construction of simpler point machines. The point lock consists of a hook lock or, more recently, of a clamp type lock. In Germany, hump switches are not equipped with point locks. The safe position of the point blades is secured by an exceptionally great retaining force. The toggle joint point lock — frequently installed in the past and still available in Germany — is now no longer used.

In Germany, electrically operated trailable points as well as derailing switches have not been rigidly (additionally) locked for about 10 to 15 years; they are only fitted with point detectors. The same practice is applied in Austria.

The rigid or flexible mounting of the point machine depends on the design of the machine used. Rigid mounting — conventional in Austria — has been recently tested in Germany. The tests concern point machines where the operating force is transmitted to the tongues by means of a rotary movement (similar to that of a crank). With this method, a rigid mounting is indispensable in order to avoid any tipping of the device. The presently used method consists of an elastic (oscillating) mounting and avoids the transmission of undesired shocks on the points to the drive. The travel of the tongues of conventional points is 160 mm; the stroke of the machine is in both countries the same, 220 mm. The travel of the tongues of the German hump switches is 150 mm and the stroke is 150 mm.

Point detection.

There are different methods of electrically detecting controlled switches :

a) internal electric detection, proving that the bar, or that part which moves the two tongues of the points connected by a rigid or articulated rod, has travelled the full stroke;

b) internal electric detection, proving that the two bars which move the two tongues independently, when not rigidly connected, have completed their respective stroke;

c) internal electric detection, proving that the bars or movable parts mentioned under *a*) and *b*) above *remain locked* after they have completed their stroke. In this case it is possible to provide a separate bar for each tongue and that, furthermore, only the closed one is locked;

d) detection by means of electric contacts directly actuated by the tongues, proving that the closed tongue is in the correct position. This detection can be carried out for both positions of the points or when set for the straight track only;

e) mechanical locking of the point tongues, effected simultaneously with the setting of the switch points, i.e. by means of additional stroke on the bar which moves the tongues (e.g. hook locks).

Of the above mentioned systems of detection *a*) to *e*), the D.B. and the Ö.B.B. use the methods cited under *a*) and *e*).

That mentioned under *d*) is applied in Germany only, where flat switches, with a radius of 1 200 m and more, have been installed, in order to prove the correct position of the centre lock. With these flat switches the detection remains functioning when the open tongue has a free play of 20 mm in the direction towards the stock rail and of 30 mm in the opposite direction, i.e. a total play of 50 mm. Detection and locking on the system mentioned under *c*) are applied in both countries; in this case an electro-magnetic and motor driven point lock is used.

There is no speed restriction when running over facing points.

The point detector of the D.B. is to be regarded as giving direct detection of the two tongues; with electric operation, the point detector is incorporated in the point machine. As a rule, all remotely controlled points, taken facing by passenger trains, and all derailing switches, are detected by in this manner. The same equipment is used in Austria.

Point machines, basically the same, are used by both Administrations for the different types of switches (normal switches, heavy type switches, articulated switches, and flexible switches); however, different operating and retaining forces, and operating times are applied for normal, heavy and hump switches. The operating forces used in Austria range between 250 to 400 kg and the retaining force is uniformly 250 kg while operating times varying from 1.5 to 5 sec. are normally used.

The corresponding data for the D.B. are as follows :

TYPE OF SWITCH	Operating force kg	Operating time sec	Retaining force kg	Gear ratio	
				3-phase current	D.C.
Normal switches	min. 250	2.2 to 3	250 to 330	1 : 5	1 : 7
Heavy switsches	max. 500	5 to 6		1 : 7	1 : 10
Hump switches	max. 125	0.8 to 1	380 to 480	1 : 2.4	1 : 3

The short operating time and the exceptionally great retaining forces met with in the case of hump switches are due to the fact that they are not provided with point locks.

Both Austrian and German point machines are capable of being connected to either side of the switch, but only in such a manner that the force is exerted on an extension of the point stretcher.

Local batteries installed near the point machines are not used in Austria or Germany.

In Germany the operating current is independent of the traction system (steam operated lines, and D.C. or A.C. electrified lines), and the following types are used : 136 V D.C., 220 V A.C. (50 cycles), and 380 V three phase current (the latter only in connection with all-relay signalboxes; the German all-relay signalbox has a desk panel apparatus with all control lamps and operating levers arranged on this panel). With electric signalboxes of the old design a 34 V D.C. is employed for incoming indications and a 60 V D.C. in the case of an all-relay signalbox. In Austria, 120 V D.C. is used for operating the switches on steam lines and 220 V (50 cycles) single-phase current (supplied from the network of the local supply company) or 180 V (16 2/3 cycles) single-phase current (from the overhead contact wire) in case of electrified lines. For indication pur-

poses a 36 or 60 V D.C. is exclusively used in all modern installations.

The starting current of the Austrian D.C. motor is not voluntarily reduced and its intensity is approximately 9 A; when operating, the current intensity is reduced to a value of about 5 A. The corresponding intensities for an A.C. motor are 7 and 4 A.

The starting current intensity of the German D.C. motor amounts to 7 to 10 A which is reduced to 3 to 5 A depending, in each case, on the switch design. The German three-phase current motor with voluntarily reduced maximum starting current requires a starting current intensity of 6 A and a current intensity of 1.4 A when it is running.

As soon as the machine has been operated to the desired position, the control current is interrupted. If the final position of the point machine cannot be attained the current is automatically cut off in the signalbox, to protect the motor. The point machine has been fitted with control circuit contacts. Both countries use independent circuits for the transmission of the control current from the signalbox to the point machine.

Motors operating on various kinds of current are not installed in the same installation.

All the above mentioned motors are capable of running in both directions. The gears incorporate straight teeth and worm gears. The German standard point machine has been provided with a worm gear and rack and pinion; tests with a point machine provided with a so-called « spur wheel lever gear » are now being carried out.

With remotely controlled switches there is no need to use machines different from those employed for switches directly controlled from a signalbox. Both the Ö.B.B. and D.B. consider it most suitable with remotely controlled switches, to provide local electric operating facilities; but the Ö.B.B. only at switches used for shunting movements. All remotely controlled switches adapted to permit local operation, must first be electrically released from the controlling point, and the O.B.B. require the final position of the switches normal or reversed, repeated in each case to the central signalbox. In addition to this electric local control, the switches can be also manually operated. In Austria, by reversing a special circuit closer all circuits connected to the point machine are disconnected. With German standard three-phase current point machines it is absolutely necessary to disconnect all cable conductors if the machine is connected to an all-relay signalbox. The operating crank can only be inserted into the point machine, following the operation of a special switch. If D.C. point machines are used, the control current can only be cut off if the fuses concerned in the signalbox are removed.

It is not customary in Austria, if local operation is applied (i.e. the switches are operated manually), to repeat the position of the points to the remote control apparatus; it is sufficient to notify the position by telephone. Moreover, a route involving locally operated points cannot be set up. The German system, on the contrary, obtains the interlocking between switches and routes by means of switch locks in connection with a special interlocked lock located in the signalbox. With modern signalboxes (all-relay signalboxes), the switch is always and automatically made dependent on the setting of a route by a special device, which functions simultaneously with the actuation of the route button.

The three-phase point machine of the D.B. used in connection with all-relay signalboxes can be disconnected by means of a circuit-breaker fixed to the cable end connection of the point machine in order to permit the carrying out of minor maintenance jobs (protection of the maintenance staff). Premature or untimely switch movements and false transmission of indications are made impossible by means of adequate circuit arrangements and per-

manent checking of the condition of the cable conductors.

In Austria, these measures are supplemented by special tests to ascertain whether there is contact to earth, and whether the conductors are properly insulated. The repeated operation of a switch in order to remove any obstacle between the tongue and stock rail (snow, stones, etc.) is permitted in both countries. The average number of working hours per year spent on the maintenance of point machines is 16 in Germany.

Trailable points.

Special devices permit of the trailing of points without damaging the point machine, as long as shunting movements are carried out without setting up definite shunting routes. All switches in Germany and Austria can be trailed. Switches when locked by an additional lock cannot be trailed, and should they be then forced open the locking mechanism is destroyed.

For the last 10 years remotely controlled switches in a running route have not been locked in Germany. In Austria, all switches taken at speeds exceeding 60 km per hour must be locked. As a rule, the trailing of switches is prohibited in Germany, though all switches are trailable. For this reason, regulations concerning maximum speeds have not been laid down; it must be mentioned that the maximum permissible speed for shunting movements is 25 km per hour.

The German switches which have a point lock, where the tongues are moved by an articulated bar (switches of normal design), function as follows : during the trailing operation of the switch the flange of the wheel first presses against the open tongue which, by its movement, releases the point lock and then also moves the closed blade by means of the stretcher rod; the driving rod acts on the transmission of the point machine and unlocks the retaining disc. This reverses the circuit control levers, blows the detection circuit fuses and de-energizes the detection magnet; in case of an all-relay signalbox this entails the energizing of the trailing relay and the fact that the points have been trailed is indicated on the panel by means of a flash light.

Hump switches without point locks have their tongues rigidly connected by a bar. In this case the flange of the wheel first presses against the open tongue and then both are moved, since they are rigidly connected. The driving rod acts on the rodding of the transmission as described above for switches provided with point locks.

The motor is coupled to the driving portion of the equipment by a clutch. Operation can be reversed, regardless of the position of the tongues. The mechanical transmission from the motor does not become separated from the rest of the mechanism during a trailing movement; it is only necessary to overcome the retaining force.

In the case of an all-relay signalbox should a switch become trailed the line representing the track on the control panel is illuminated in red in the direction from which the switch was trailed. Each trailing movement is registered by a counting device. The apparatus indicating the trailing holds all route levers until the trailed switch has been returned to its normal position. In Austria, a flash light also is used to indicate that a switch has been trailed. However, it is possible to establish a route over such a switch. In both countries, the tongues remain in their respective positions after having been trailed, but it should be mentioned that, in most cases, the point lock does not attain its final position.

The Austrian and German requirements in respect of electric point machine are in general principles the same. For obvious reasons, the German operating system, with its severer requirements — in particular regarding modern all-relay « panel » signalboxes and C.T.C. lines — requires the construction of more elaborate electric point machines; the new German three-phase cur-

rent point machine is to be so regarded. If the German point machine only has been described in detail this is due to the fact that the Ö. B.B. answers to a great number of questions unfortunately were not always complete.

It is necessary to consider, in connection with the answers concerning remote control of signalboxes, that there are no C.T.C. lines in Austria and the development of remote control has not yet achieved the German standard. However, it must be emphasized that, in spite of this, the answers to question 6 a) were very instructive.

NEW BOOKS AND PUBLICATIONS.

[385 .02]

Directory of Railway Officials & Year Book, 1953-1954. — London : Tothill Press Limited, 33 Tothill street, Westminster, S. W. 1. — One volume of 530 pages (8 1/2 × 5 1/2 in.) Price : 40 sh. net.

The *Directory of Railway Officials & Year Book 1953-1954* reaches with the present volume its 59th year of publication.

The first edition was compiled from official sources and issued in 1895, and at that time some 270 pages sufficed to cover the text including an index to countries, an index to names of railways and the comprehensive personal index of railway officials, which is still a noteworthy feature of the volume.

The present edition should prove as valuable as its predecessors, and there has been no markedly change in the presentation of this volume with the current edition, but it has been found possible by typographical economies to reduce the number of pages slightly without sacrificing any information. All entries continue to be divided into one of two main divisions, namely, British Commonwealth (regardless of Dominion or Colonial status) and Foreign; each of these sections is again subdivided geographically into continents and countries.

In the Asian section, Cambodia and Viet-Nam have been added. For the first time, it has been possible to give extensive details of the personnel and reallocation of lines resulting from the reorganisation of the Indian Railways.

Once again, it has been impossible to secure reliable information from most of the « iron curtain » countries of Eastern Europe.

Statistics specially prepared by the British Transport Commission and maps of the Divisional Waterways Organisation and of the Road Haulage Divisions are included.

As in the past, this manual will be found of invaluable interest to all those interested in railway matters.

A. U.